SHOP EQUIPMENT NUMBER

Railway Mechanical Engineer

VOLUME 91, NUMBER 6 — ESTABLISHED IN 1832

NEW YORK: Woolworth Building
CHICAGO: Transportation Building

New York—JUNE, 1917—Chicago

CLEVELAND: Citizens Building
WASHINGTON: Home Life Bldg.

Engineering Library

JUN 16 1917

UNIV. OF MICH.

"NATIONAL" Preparedness

A gentleman once said to a representative of the National Tube Company—"What can you say about pipe; it's simply a bunch of air with a piece of steel around it." An immediate answer was not available, but shortly after this a book, "*The Age of Power*," written by an engineer, came to the attention of the person addressed—and the theme was this: There is less difference than is usually supposed between the 20th Century and, say, the 10th or 12th or any other previous Century. There is nothing new under the sun. There is a difference, however, in the externals and this difference can be reduced to some phase of the *Generation, Transmission and Use of Power* and the Ramifications *thereof.*

Inasmuch as pipe is an essential part of power, this would seem to be an interesting idea.

An attempt was made to elaborate the theme in prose, without much success. The matter was then put into the hands of Berton Braley (the poet of industry) and the following poem is the result. The whole thought of the poem is contained in the next to the last line—"Framework of civilization is wrought of it." It should be noted that this poem has particular reference to *daily living* preparedness, and not in any way to *military* preparedness.

ARE we prepared? Yes, for every emergency
Every contingency under the skies;
Ready for cases of danger and urgency,
Ready for commonplace needs that arise;
Fully prepared for our labor or pleasuring,
Armored and armed for the course to be fared,
Fit for each chance that the mind can be measuring—
"NATIONAL" Tubing has made us prepared

"NATIONAL" tubing prepares us for traveling
Carries the steam that is driving the train,
Keeps us in ease as the miles are unraveling
Over the mountains and over the plain;
"NATIONAL" Tubing brings water of purity
Into our homes from the far-away hills;
Stands at our windows, a guard of security;
Brings us our gas—and the drudgery kills!

WHY, from the time we are infants in carriages
(Go-carts of "NATIONAL" Tube, as you know),
Up through our childhood, our loves and our marriages,
On till our tresses are covered with snow,
"NATIONAL" Tubing's assisting and aiding us
Keeping us warm when the icy winds blare,
Holding up awnings, in summer, for shading us.
—"NATIONAL" Tubing has helped us prepare.

CASING for oil wells, shafts for machinery,
Pipes for the drills digging copper and gold
Poles for the power wires looping the scenery,
Frames for the plows that are turning the mold;
"NATIONAL" Tube, in a thousand varieties,
Serves for ten thousand requirements of life,
Whether in places where comfort and quiet is
Or in the midst of the heat and the strife.

SO when we speak of preparedness "NATIONAL",
"NATIONAL" Tubing is there—it's a pipe!
Fully prepared for the needs that are rational,
Builded for service of many a type;
Dreamers have dreamed and the thinkers have thought of it,
Till every nation its service has shared;
Framework of civilization is wrought of it,
"NATIONAL" Tubing has made us prepared!

BY BERTON BRALEY

"NATIONAL" Pipe Is Made by National Tube Company, Pittsburgh, Pa.

William Sellers & Co. Incorp.

PHILADELPHIA, PA.

STEEL-BRONZE COUPLING NUT

Patented July 14, 1914.

"SAFETY FIRST"

BRONZE RING—Non-Rusting Threads
STEEL BAND — Non-Breaking Slots

Sizes to fit any kind of locomotive injector or valve, 1½ to 3-inch pipes, Iron, screwed; brazed or beaded copper pipe connections. Can be substituted for screwed flanges.

Superior to All-Brass Nuts or Flanges.

Cannot split, crack or strip threads.

Superior to All-Steel Nuts, which destroy threads of branches and cut the pipe conections.

Not liable to damage by spanner wrench or set.

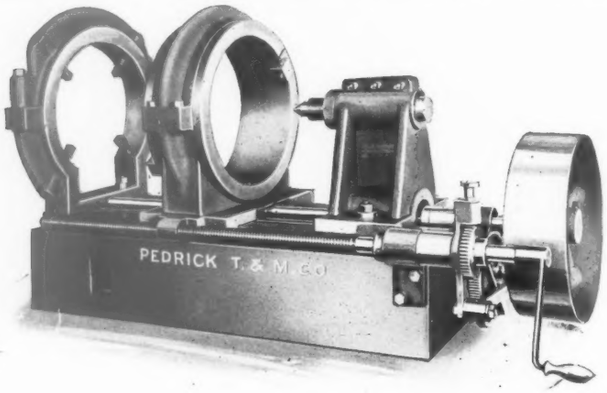
The internal bronze part is cast by a special process within the steel band and united to it by cross ribs and dovetails, forming one solid piece. It is 20 per cent stronger than the ordinary All-Brass Nut.

LABOR SAVING MACHINE TOOLS

DRILL-GRINDERS SHAFTING INJECTORS TOOL-GRINDERS

THE PEDRICK CRANK PIN TURNING MACHINE IS USED BY THE LARGEST LINES

All Sizes



Universal

BECAUSE:

1—It is adjustable for long or short pins,
2—Easily set up and aligned by means of the tail stock and setting head,
3—Less parts, substantial bearings that do not bind, strong one piece driving shaft.

These are exclusive features of the PEDRICK machine and assure your obtaining the utmost convenience, adaptability and accuracy.

PEDRICK TOOL & MACHINE COMPANY

3641 N. Lawrence Street **Philadelphia, Pa.**

Builders: Portable Cylinder Boring Bars, Pipe Benders, Etc.

Railway Mechanical Engineer

Volume 91 June, 1917 No. 6

CONTENTS

EDITORIALS:
- Rod Job Competition ... 283
- Mechanical Department Valuation Organization ... 283
- Rules for Loading Lumber ... 283
- Conserve Your Fuel Supply ... 284
- Buy a Liberty Bond ... 284
- Locomotive Feedwater Heating ... 284
- Keeping Cars In Service ... 285
- Car Shortage or Congestion? ... 285
- New Machine Tools Versus Old Tools ... 286
- "Do Your Bit" ... 287
- Greater Shop Output Required ... 287
- New Books ... 288

GENERAL:
- Centralized Production of Locomotive Repair Parts ... 289
- Selection of Machine Tools ... 292
- Power Tests of Machine Tools ... 294
- Developments In Railway Shop Tools ... 297
- Improve Railroad Efficiency ... 299
- Fuel Association Convention ... 301
- The Machine Tool Situation ... 306

SHOP PRACTICE:
- Electric Welding on the Rock Island ... 307
- Grinding and Milling Work ... 309
- Rack for Storing Boiler Sheet Stock ... 314
- Increasing Output and Reducing Unit Costs ... 315
- Locomotive Rod Job ... 317
- Milling Machines In Railroad Shops ... 321
- Welding a Cracked Cylinder ... 322
- Gages for Determining the Lift of Air Pump Valves ... 322

LOCOMOTIVES:
- Locomotive Feedwater Heating ... 323
- Mikado Type Locomotive Tests ... 328
- Kindling Fires in Locomotives ... 332
- Philadelphia & Reading Mallet Locomotives ... 333
- Good Firing ... 334

CAR DEPARTMENT:
- The Lubrication of Freight Cars in Interchange ... 335
- Wooden Framed Freight Equipment Cars ... 336
- Santa Fe Double Deck Stock Cars ... 337
- Importance of Proper Loading of Cars ... 341
- Reducing Breaks-in-Two on the Santa Fe ... 341
- Air Brake Association Convention ... 342
- Erie Dining Cars With Unique Table Arrangement ... 346

NEW DEVICES:
- Plain Grinding Machines ... 347
- "Cisco" Relieving Attachment ... 348
- Libby High Power Turret Lathe ... 349
- Cincinnati Planer ... 350
- Morris Standard Engine Lathe ... 351
- All-Geared Drill and Tapper ... 351
- Ball Bearing Bench and Floor Grinders ... 352
- Armstrong Tool Holders ... 352
- American Flexible Staybolt ... 353
- Vertical Surface Grinding Machine ... 353
- Back Geared Crank Shaper ... 354
- Valveless Boiler Scaler ... 354
- Flue Reclaiming Attachment ... 354
- Quick Releasing Face Milling Cutter ... 355
- Type "C" Dumore Grinder ... 355
- A Handy Pipe Vise ... 356
- Flexible Pipe Connection ... 356
- Automatic Metal Cutting-Off Machines ... 356
- Loco Light Headlight Equipment ... 357
- Expansion Joint with Crosshead Guide ... 357

NEWS DEPARTMENT:
- Notes ... 358
- Meetings and Conventions ... 360
- Personal Mention ... 361
- Supply Trade Notes ... 365

Rod Job Competition

The rod job competition, which closed May 1, was participated in by eight contestants. The judges awarded the first prize to Ernest A. Miller and his contribution appears elsewhere in this issue. The second prize was awarded to H. M. Brown, shop superintendent, Chesapeake & Ohio, and the third prize to James Grant of the Great Northern. These two latter papers will be published in future issues in connection with such of those of the other contestants as have been accepted for publication. One contribution was submitted anonymously and for that reason had to be excluded from consideration by the judges. Conditions in different shops will, of course, govern to a large extent the practices followed, but in many cases some shops may be doing certain parts of the work more economically than others; if so we shall be glad to hear from them.

Mechanical Department Valuation Organization

The mechanical departments of some roads have tried to evade active participation in the valuation work. This is poor policy. If a proper valuation is to be made the men most familiar with the material or property being valuated should be used. There should be one man in charge of mechanical department valuation and he should be thoroughly familiar with the road, its shops and equipment. For assistants he should have under him men more familiar with the details than he. At best, the mechanical department valuation is difficult. There is a greater amount of capital represented in the property under the control of the mechanical department than is generally realized, and the cost and value of this property must be carefully determined. Where changes have been made, and there is hardly a case where they have not been made, no one is better able to determine what they have been, how they should be charged, and what they amounted to, than the men who have directly followed this work. It is important therefore that every mechanical department should do its share in the onerous work of valuation.

Rules for Loading Lumber

Shipments of dressed lumber probably necessitate more shifting and transferring of loads than those of any other one commodity. A great deal of trouble is experienced with flat and gondola cars which are loaded strictly in accordance with the rules, the load shifting and either fouling the brake staff or extending over the end of the car. Inspection of loads which have shifted often reveals the fact that boards have not been overlapped properly, resulting in parts of certain tiers being free to move and sliding when starting or stopping, but the same trouble can be found where the loading has been properly done. Wooden frame box cars loaded with lumber often have the whole end torn loose by the shifting of the load and even in cars of the most substantial end construction the end posts are often bent in the same way. It is important for the rail-

roads to find some method of securing dressed lumber which will avoid the trouble experienced under the present methods of loading. It may be that raising the end of the tiers will have the desired effect. If that does not prove feasible an inexpensive form of end support for flat and gondola cars will probably remove the principal difficulty. The danger to train men, the damage to equipment and the delays to loads justify the adoption of whatever measures may be found necessary to do away with the troubles now so often encountered with loads of dressed lumber.

Conserve Your Fuel Supply

The railroads are having extreme difficulty in contracting for their coal for the coming year. Some of the largest roads have been able to contract for only 50 per cent of their fuel requirements at a very substantial increase in price. The other 50 per cent must be bought in the market, the increase in price being far in excess of 50 per cent. Estimates from various authoritative sources indicate that the railways will have to pay over $100,000,000 more for coal this year than last. This makes necessary the most careful use of fuel from the time it leaves the mines until it is thoroughly consumed. The International Railway Fuel Associatiton, appreciating this condition, adopted at its recent convention a complete set of suggestions which, if followed, will aid materially in the conservation of fuel. These are published on other pages of this issue in connection with the report of the convention. The seriousness of the situation demands that these recommendations be given the most thoughtful consideration. They are familiar to many of our readers and to those who have followed the Fuel Association proceedings carefully. Some of the items have been tried and found uneconomical, but should now be reconsidered as the great increase in the price of fuel gives a very different aspect to the problem and furnishes a new basis on which to work.

The output of our factories and mills has tremendously increased and they must have coal in larger quantities. In addition to this, the United States will be called upon to furnish a large amount of fuel to France and Italy. This again will make deep inroads into our fuel supply. It is, therefore, the patriotic duty of every man handling fuel on the railroads to make every pound do its utmost, releasing as much as possible for the use of others, as well as decreasing the cost of locomotive operation.

Buy a Liberty Bond

First, they formed the Railroads' War Board; next, they proceeded to form nine engineer regiments for service in France; then, they made large subscriptions to the War Loan, and now, they are going to assist their employees to buy Liberty Bonds. Certainly, the American people have reason to be proud of the way their railways have joined the vanguard in the present crisis. It is now up to railway officers and employees to help the railways stay in the first division; and they can help in two ways, one by doing their level best at their daily tasks of keeping the transportation system at its high notch of efficiency and the other by buying a Liberty Bond. Railwaymen will not easily be spared for service in the field. But, if they cannot shoot leaden bullets they can shoot silver bullets; they can buy Liberty Bonds.

Nearly all the railways have offered their employees opportunity to subscribe on a partial payment plan. It should not be hard to pay for a $50 or a $100 bond in 5 or 10 or 12 monthly installments and even if his railroad has not yet acted, an officer or an employee can buy a bond from his bank. Secretary McAdoo says that a $50 bond can be bought for 2 per cent or $1 on application, 18 per cent ($9) on June 28, 20 per cent ($10) on July 30, 30 per cent ($15) on August 15 and 30 per cent on August 30. Certainly railwaymen lack no incentive to subscribe. And the bonds are good investments, 3½ per cent, tax free and convertible into higher interest paying bonds if such are later issued. But what is most important, railwaymen who subscribe help their country in a very practical patriotic way. The United States offers these bonds in low denominations and on easy payments because it is your subscription it wants. It wants subscribers rather than money. It wants to show that the people are behind this fight for the liberties of mankind. Subscribe and show your fellowmen and the foe across the sea where you stand.

Locomotive Feedwater Heating

At the recent convention of the International Railway Fuel Association an exhaustive report was presented on locomotive feedwater heating, an abstract of which appears elsewhere in this issue. Both the exhaust steam and waste gas methods of preheating feedwater were discussed. For maximum economy, the feedwater must be brought from the temperature of the water in the tank to the temperature of the water in the boiler by using the smallest possible amount of steam direct from the boiler. A large amount of live steam is required where the injector is used, and the water is heated to about 160 deg. by the steam with no economy in heat. In this case, therefore, the saving to be made by preheating with the wasted heat must lie between the heat contained in the water at 160 deg. and the heat in the water when it is raised to the highest temperature the feedwater heater is susceptible of furnishing. Where a steam-driven pump is used, the wasted heat can start its preheating at the temperature of the water in the tank. This will be found to be the more economical thing to do, as locomotive feedwater pumps are provided that will pump five and six times as much water per pound of steam as the injector.

The maximum amount of preheat that it is possible to add to the feedwater by the exhaust steam method is limited to the temperature of the exhaust steam, which is about 140 deg. less than that of the temperature of the saturated steam in the boiler. On the other hand, the temperature of the gases passing out through the stack is from 600 to 700 deg., or over 200 deg. higher than the temperature of the steam in the boiler. However, there is about three times as much heat available in the exhaust steam as in the waste gases and further, the heat is abstracted from the exhaust steam far easier than it is from the waste gases and a much smaller amount of heating surface is required to give the same amount of preheat. At the present time both methods are more or less in the experimental stage. The exhaust steam method is being rapidly developed and developments are planned for the waste gas method. Extensive tests are being made on the exhaust steam type of feedwater heater, and from the results thus far obtained it has been shown that a net saving in fuel economy of over 10 per cent may be expected. As the smokebox heater is developed and the two methods are used in conjunction with each other, greater economy in fuel will be obtained. Coupled with this economy, the maintenance problems of the two types of heater must be carefully considered. This, of course, can only be determined accurately after the heaters have been tried out in actual service on several locomotives in regular road work.

Feedwater heating in Europe is used to a far greater extent than on this side of the water. Foreign roads have evidently found it successful, or it would not have been developed as far as it has. It remains for us on this side to adapt the problems of feedwater heating to our conditions. A certain amount of experimenting is necessary and the railroads should not hesitate to co-operate to the fullest ex-

tent with the committee of the Fuel Association in developing this new refinement in locomotive construction, which at the present time offers such attractive results.

Keeping Cars in Service

The Railway War Board in a bulletin issued on May 9, the text of which is published elsewhere in this issue, has called attention to a number of ways of increasing car efficiency, which if carried out will have the effect of increasing the available number of cars over 700,000, or slightly more than 30 per cent of the total number of freight cars now in existence. One of these suggestions is that a reduction of between two and three per cent be made in the number of cars out of service for repairs, thereby increasing the cars available for service by about 64,000.

Unlike locomotives, which are shopped on a mileage basis, the percentage of cars out of service for repairs is a reflection of previous maintenance policies and of the character of the construction rather than of the service being rendered. In devising ways and means of reducing the number of cars out of service for repairs, less attention, therefore, need be given to increasing facilities and labor than to locating weaknesses in design and correcting them when heavy repairs are made. It hardly need be stated that for months to come it is absolutely essential that the maximum of results be obtained from every hour of labor expended in maintaining equipment. To maintain some of the rolling stock now in service, as it originally was built, is little short of a sheer waste of effort. Such equipment leaves the repair track only to appear on another one a few days later. In order not only to increase the number of cars available for service, but to avoid serious delays to traffic, it is highly important that such equipment be placed in condition to *stay off the repair track.*

Whenever special effort is directed to reducing the number of bad order cars, there is always a temptation on the part of local officers to make a showing by overlooking certain bad order conditions in the hope that the cars may get off the division or the road before failure occurs. While the immediate effect of such a policy is an apparent improvement in the number of cars out of service, eventually the results are sure to be disastrous. In the present congested conditions of many of our roads the delays, if only a few minutes each, while setting out bad order cars which should never have been placed in the trains, causes a loss of transportation efficiency far greater than can be compensated for by any increase in the available number of cars effected by such a policy. It is a question whether the car shortage which has been apparent for some months past is not less an actual shortage than a congestion which has reduced the available supply. It must be clear then, that no policy of slighting essential repairs should be tolerated in the present emergency.

The efforts of the car department must be concentrated on underframes, draft gears, trucks and brake rigging. That repairs to these parts be thoroughly done and that weak designs be strengthened to withstand the severe shocks of present day service is essential. Other parts may be patched up or even allowed to deteriorate to a certain extent without serious consequences. There are a large number of wooden cars in service which are too weak to withstand service conditions on many of the roads to which they are offered in interchange. As fast as materials can be obtained, these cars should be fitted with some form of continuous steel center sill construction or at least with steel draft arms. Such changes undoubtedly may be unnecesary to meet the conditions on the home road. It must be remembered, however, that the railroads are now operating as a single system and that it is esesntial as never before that cars all be of sufficient strength to withstand the severest conditions anywhere to be met with. Arch bar trucks of weak construction, especially those with flat compression members, should be replaced as fast as material for new ones of improved design can be secured.

The cost of making such changes at the present time no doubt will be high, but in the face of a constantly decreasing supply of labor the only way it will be possible to keep the number of bad order cars within reasonable limits, is to send the cars out from the shops in such condition that they may be expected to stay out for months and not days. The war is not yet over; it may last for a year, two years, even longer. Any slighting of the maintenance of essential parts of the car for the immediate advantage which may be gained thereby will be disastrous later when the conditions of the labor market are even worse than at present and when the demands of the nation for transportation are even greater and more insistent than at the present time.

Car Shortage or Congestion?

Railway mechanical department officers, the country over, are trying to figure out whether it is a car shortage or a car congestion that is bothering them. We will not presume to answer the question, but will outline certain facts that may throw light on the situation.

Since the first of January the railways of the United States and Canada have ordered no less than 1,941 locomotives, as compared with only 1,691 in the first five months of 1916. The freight car orders on the other hand have totaled only 33,840, whereas at this time last year they had reached 49,-851. It is worth while at this point to add also that the big Russian orders, 500 locomotives and 10,000 cars, reported this last week have brought the totals of foreign equipment ordered to no less than 1,094 locomotives and 24,550 freight cars as against only 634 locomotives and 18,325 cars in the first five months of 1916. The big orders for locomotives, both foreign and domestic, are naturally attracting a great deal of attention, and observers are seeking to find the reason for the continued large buying of power, realizing that it is in spite of extraordinary high prices and deliveries now extending well beyond April or May of next year.

Take the matter of locomotive prices. R. H. Aishton, president of the Chicago & North Western told the Interstate Commerce Commission in the rate advance hearings that during the past 10 years his road had spent on an average slightly over $6,000,000 a year for new equipment, receiving on that basis an average of 4,000 freight cars, 94 passenger cars, and 94 locomotives. In 1917, for $6,444,-000 it received only 2,000 coal cars and 50 locomotives. W. B. Biddle, president of the Frisco similarly said that his road bought locomotives in February, 1916, for $36,750 each; that later in the year it had to pay $51,000 for the same type of locomotive and that in February this year it inquired for locomotives and was told that the lowest price was $69,750. Howard Elliott declared that locomotives that cost $50,350 in January 1917 cost $57,320 in March, 1917, an increase of 13.8 per cent in less than three months. He also presented the following comparison of prices:

Date.	Type.	Weight.	Cost per lb.
November, 1915	Mikado	400,000 lb.	6.65 cents
February, 1916	Pacific	329,000 lb.	8.53 cents
March, 1917	Santa Fe	441,000 lb.	13. cents

He further added that a 50-ton steel hopper car costing $1,-215 in January, 1916, would cost about $2,800 today.

The point is that despite the high prices for locomotives, the domestic orders reported from January 1 to June 1, 1917, were larger than those in a similar period for at least the last four years. This surely indicates that the railways need locomotives and need them badly.

The railways also need cars, but for some reason the or-

ders for cars are not so great as conditions might seem to demand. The railways, of course, are appalled at the high prices they have to pay for new equipment. There is some reason to believe that the builders, owing to the uncertainties of the present situation, are not eager to tie themselves up with long term contracts. Besides, there is no doubt that many railway men believe that the present difficulty is a matter of congestion rather than of car shortage and that they hope for improvement through the work of publicity to shippers and through the work of the Car Service Committee. Nor must we neglect the argument brought up not so many months since that it is not fair to ask the railways to buy cars that would remain idle during the long periods of car surplus. President Rea, of the Pennsylvania, added a further thought when he stated before the Interstate Commerce Commission that, "Some say that more cars would only add to the congestion," and that, "if the Pennsylvania were instantly given a lot of cars, they would be immediately scattered to the four winds." He added, however, "I think if we had more open top cars, they could be put to good use. I think that if we could get deliveries and the prices were reasonable, we should get coal cars, possibly 5,000, but I wouldn't pay the present prices for them."

The question, in short, is put up entirely to the mechanical department. The railways must use their locomotives, new and old, to the best possible advantage. They will have difficulty in getting new ones because of the high prices and slow deliveries and the competition for space on the part of the foreign orders. The Russian Government alone now has considerable over 700 locomotives on order in this country, and a committe of which S. M. Vauclain is chairman is investigating to see, among other things, if perhaps we cannot furnish even more locomotives to our allies overseas.

The mechanical department officers must realize further, as we emphasized last month, that this shortage of power is going to continue and perhaps become more acute from month to month, although it is possible that the contemplated reductions in passenger service may release sufficient power to counteract in some measure the increased demands for locomotives resulting from an increased traffic to the seaboard and to the 32 concentration camps which will soon be under way.

It may easily be seen that conditions are becoming such that any railway that wishes to retire locomotives from service should consider the step carefully, and it is axiomatic that now as never before, should mechanical department officers be careful that all engines in service are kept in the best condition possible under the circumstances.

New Machine Tools Versus Old Tools

The master mechanic was showing a visitor through the shop and they paused at the wheel lathe which was turning off heavy, blue chips. "Before we got that machine," said the master mechanic, "we kept five lathes busy turning wheels and we were nearly always working some of them overtime. Now we have scrapped all but one of the old machines and we don't have any trouble in getting our output. We're up against the same sort of a proposition with our driving boxes now, and I'm having just as hard a time getting the machines I want as I had when I asked for this wheel lathe. I don't see why we can't get enough money appropriated to buy the tools we need."

The master mechanic's complaint is one that is heard time and again. On most railroads it is hard to get money appropriated for machine tools, much harder than it is to get new locomotives or cars, for instance. It is not uncommon to find roads with the most modern type of motive power having poor shop equipment. This is a natural condition, for the railroads have found it difficult to raise money and the tendency is to spend it where it will have most direct and apparent effect on the cost of operation. The saving effected by the elimination of old tools is as a rule not especially apparent but a policy of systematic replacement is a vital factor in keeping up the efficiency of a shop. Modern machine tools will pay a high return on the investment and obsolete tools should be retired as rapidly as possible.

At the present time it is a difficult matter to secure skilled mechanics and the wages paid by railroads for that class of labor are higher than ever before. The demand for men will be further increased, and the supply depleted by the war. For these reasons it is important that the railroads secure tools that will give the maximum production per man. This applies not only to large points where highly specialized machines are required, but also to small points where machines which can be used on a wide range of work, but equipped with time and labor saving devices, should be installed. Old machines are too often retained in service where a modern tool would save enough in wages to more than pay its cost. Old, low-power machines are hard to handle, besides being inaccurate, and there is no excuse for retaining them in service except where the machine is used only for emergency work. Highly specialized machines should be installed wherever possible, particularly if unskilled labor can be employed to operate them.

An instance which shows the saving of men and money that can often be effected by discarding old tools occurred in a locomotive shop where a great deal of heavy boiler work is done. Three lathes had been fitted with special attachments for finishing crown stays but they gave considerable trouble. If the machines were speeded up to secure greater production the stays bore chatter marks and could not be made tight. A special machine was secured for this work and not only did its production exceed that of the three lathes previously used, but it was readily operated by an apprentice and the quality of the work was all that could be desired.

Sometimes a single inefficient machine holds down the production of the whole shop. Where such conditions exist it is easy to locate the trouble. More often such difficulty is due to having a number of machines which are inadequate to meet the demands made upon them. A shop scheduling system is of great value under such circumstances, as it shows up the weak points of the shop and makes it easy to pick out the machines that are "slackers."

It is unfortunate that the shop accounting methods ordinarily used do not show up more clearly the effect of substituting new tools for old ones. Inefficient tools increase the overhead or surcharge on shop work by reason of their low production. The only way to keep a shop efficient and the overhead expense down is to replace the shop tools systematically.

Many of the tools built before the introduction of high speed steel are uneconomical because of the limited production of which they are capable. Modern tools installed in their places would reduce the cost of the work enough to pay a high rate of return on their cost. It seems to be hard for many men to scrap machinery before it is entirely worn out, but it is often the economical thing to do. The introduction of high speed steel has rendered many machine tools built 15 or even 10 years ago obsolete. It is probable that the heavy, high powered tools now built will not have to be retired until they are worn out; in other words, depreciation of tools built at the present time will be less than that of tools built prior to the advent of high speed steel.

The railroads are now in such urgent need of additional terminal facilities, extra tracks and more rolling stock that there is a tendency to keep down the capital expenditure for new tools. The best basis for tool replacement is a regular depreciation reserve set aside every year and devoted solely

to the replacement of tools. Such a policy will do a great deal toward keeping shop methods up to date and reducing the expense of equipment maintenance.

"Do Your Bit"

The railways of this country have a tremendous task to perform. For many months they have operated under heavy pressure and abnormal conditions. Now at a time when ordinarily they would have a breathing space to put their equipment and facilities into better condition, they are confronted with the necessity of moving still greater quantities of supplies and material and of shortly being required to handle large forces of troops and military equipment for the government. It is impossible to add to any very great extent, in the immediate future, to the present equipment or facilities, because of the inability of the manufacturers to furnish the equipment. On the other hand, this is no time for lament or faultfinding at the lack of preparedness or on the foolishness of the misguided regulators and politicians with their restrictive rather than constructive programs, which are largely responsible for the financial difficulties which have confronted the railroads in the last few years.

The emergency is upon us and ways and means must be found to overcome the lack of facilities and equipment and to make up for the men that are being called to the colors. How can it be done? A circular which was issued by the Railroad War Board is published in this issue, or at least such parts of it as are likely to prove of special interest to the mechanical department. It deals with some of the ways in which it may be possible to secure better results. Studying it in a broad way, and reading between the lines, one cannot but grasp the underlying thought upon which it is based, and that is that such improvement as may be made is almost entirely dependent upon each individual in the entire railway organization heartily putting his shoulder to the task and increasing his individual productive capacity to the uttermost. This does not mean forcing one's self to the point of exhaustion; rather does it mean using every means to cut out waste and lost motion, of playing the game skillfully and intelligently in order to get better results. Sometimes we get into a rut and almost literally go ahead with blinders on. Standing back and sizing up the job in a big and analytical way may show us the fallacy of making certain routine moves that we have always considered necessary, may help us to do the job in three-quarters of the time with the expenditure of no greater energy and with just as good results. Here is where every one of us may do our bit, whether it be the laborer in the shop, engine house or repair track, or the head of the department.

The railroads as a whole have awakened to the seriousness of the situation and have given up their individual rights—possibly at great loss to themselves as individual roads—and are operating as a single unit under the direction of the Railroad War Board at Washington. The five men on this board—Fairfax Harrison, Howard Elliott, Hale Holden, Julius Kruttschnitt and Samuel Rea—are giving practically all of their time to this problem, as is also Daniel Willard, chairman of the Advisory Commission of the Council of National Defense. The Railroad War Board is assisted by several committees, including in their membership a great number of railway executives and other experts. Many concrete things have already been accomplished which promise important results and the work has hardly been more than well started. The full success of the project will depend upon the thoroughness into which the individual roads enter into the spirit of the plan. Even though they may have subscribed to it and the boards of directors may have passed favorably upon it, the results will not be what they should if there exists a spirit of faultfinding or jealousy between the various roads. Now, if ever, is the time to put away petty jealousies and play the game for all it is worth—and the public will surely appreciate it in the end, indifferent as it may sometimes seem.

This truth holds good down through the organization of each road, and even into the ranks. Department jealousies, individual and departmental petty criticisms and faultfinding are brakes on the wheels of progress and efficiency. What is needed is plenty of the oil of human kindness, patience and good will to lubricate the organizations throughout. It is a wonderful opportunity the railroads have of making good and helping to win a great fight in the interests of democracy and righteousness. We will have to do our best with the facilities and equipment at hand and it is up to each individual employee to see that the very most is made of these tools. If the same enthusiastic spirit which has been characteristic of the safety first and the loss and damage campaigns on many roads can be put into the bigger game, there is no question as to the final outcome—and it will be done.

Greater Shop Output Required

What can be done quickly to bring up the output and efficiency of the average railroad repair shop? What is the weak spot in your shop? What class of work, or what department, is inclined to lag behind and restrict the output? These are pertinent questions at this time, when the welfare of the nation and of our allies abroad may depend on keeping our locomotives and cars in prime condition and getting the greatest possible service out of them. As important as is increased output, it must not interfere with quality of workmanship; never was there a time when it was more necessary to guard against breakdowns on the road. Some railroads are far ahead of others in the maintenance of their cars and locomotives and some shops are much better off than others in the way of improved shop practices and facilities. Helpful suggestions, based on the experiences of different shops, will be found throughout this issue, one article being devoted entirely to a consideration of recent improvements in machine tools for railway shop work. It is proposed in these comments, however, to discuss certain important general practices which may be made to give splendid returns in the way of increased output if they are not already in effect.

One of the best and quickest ways of toning up a shop organization and locating and strengthening the weak spots is to install a shop scheduling system. Such systems have been described many times in these columns; indeed, we have advocated their installation for the past 12 or 15 years and yet many shops are struggling along with the roughest and most unscientific sort of schedule and seem to have utterly failed to appreciate the remarkable results that may be obtained with a comparatively small expenditure of time and energy in installing a real shop scheduling system. Briefly, the various classes of work on each part of a locomotive are scheduled to be finished at certain predetermined times so that the work as a whole may progress steadily and without interruption in order that the locomotive will be ready for service without fail on a given date. Not only does this reduce the length of time necessary to put a locomotive through the repair shop, but the general foreman or shop superintendent is relieved of a great amount of detail and can give his time to the larger and more important problems which concern successful shop operation. A description of a typical shop scheduling system was given in a paper by Henry Gardner at the 1913 meeting of the International Railway General Foremen's Association and will be found in the *Railway Age Gazette, Mechanical Edition* of August, 1913, page 423. A shop scheduling system in use on the St. Louis & San Francisco was described in the *Railway Age Gazette, Mechanical Edition* of November, 1914, page 588.

The problem of the reclamation of waste or scrap material

has for the time being taken on a new aspect. A few years ago when materials were plenty, warnings were given that reclamation work was being carried entirely too far in some cases and emphasis was placed on better accounting methods to take into consideration the overhead or surcharge costs, as well as the direct costs, and also the necessity of following the reclaimed material into service to see that the parts gave a sufficiently satisfactory service to warrant the work that was put on them. These things are as important as ever, but the cost of material has advanced to such a point that a considerable extension in the classes and condition of materials to be reclaimed is justified. The increase in the cost of labor must not be overlooked, and this may make advisable the addition of certain facilities which under former conditions would not have been warranted. In not a few cases material is so scarce and difficult to get that if it cannot be reclaimed it is not available, and here again it may be advisable to make very considerable expenditures for facilities which under other circumstances would not be justified. The important thing is to keep the cars and locomotives in effective service as great a part of the time as possible.

Because the pages of this journal have been a clearing house for improved shop practices, shop kinks, etc., many of our readers have been able to utilize the experience of others and greatly improve the efficiency or output on certain machines or in certain departments. Attendance at the meetings of the various mechanical department associations has also been a great help and inspiration to many shop foremen and officers. To those who have not made a practice of studying the technical journals and association proceedings the suggestion is made that a study of back numbers and volumes will be very well worth while and will undoubtedly reveal many things that will be helpful in getting almost immediate results.

In recent years there has been a strong and steady tendency toward improving sanitary conditions and providing cleaner premises and more pleasant surroundings. This was done in the realization that the workmen would give better service under such conditions; it was also inspired in some degree by the safety first campaigns. This is all the more important now that there is so great competition for labor. As labor has become more scarce, there has been a tendency in some shops to become more or less careless in this respect. This is unfortunate and some means should be taken to overcome the situation; it is quite possible that women may be used to advantage for the lighter work in connection with cleaning up the shops.

It has become the practice in the larger shops for the shop superintendent to have on his staff one or more men with various titles, ranging from shop demonstrator to efficiency engineer, whose sole duty it was to devise ways and means of improving the output. Shop demonstrators have also given a splendid account of themselves in giving apprentices practical instruction. Where men of the proper training and personality can be obtained for this work there is no question but what it is a paying proposition, and shops which have not yet tried it or which have room for more experts than they now have, will do well to make the best possible use of this means of getting better results. As much as a year or two ago complaints began to come in on the falling off of shop efficiency because of the difficulty in getting and holding skilled mechanics due to the competition of munition and other industries. It is all the more necessary, therefore, to provide such demonstrators for breaking in the inexperienced help.

A wise general foreman will see that his subordinates meet with him regularly in a group in order to talk matters over. Sometimes this can be done more or less informally by having the foremen gather at one place when eating their lunch. Usually, however, a certain time is set apart each week for such meetings. The results may quickly be noticed in the better co-operation between the various parts of the organization. Try it and you will be surprised at the results.

NEW BOOKS

Turret Lathe Guide. 250 pages, illustrated, 6¼ in. by 9¼ in. Bound in cloth. Published by the Gisholt Machine Company, Madison, Wis. Price $1.

This book has been compiled for the use of operators and those who are familiar with the Gisholt turret lathe work. It was written with the intention of suggesting the most beneficial way in which to operate and take care of these machines. The use to which these turret lathes may be put, their construction and operation, are thoroughly described in the first part of the book. Under "Tooling" is given an outline of the tool equipment that is used with these lathes and the purposes to which they may be put. The methods of fitting up and handling different jobs are described and quite thoroughly illustrated. The various types of chucks to be used are described in detail. Various other parts of the machine are taken up and discussed in a similar manner. The method of grinding and forming tools is given in quite some detail. Suggested methods for cutting threads and for machining heavy pieces of metal are also given.

Steel and Its Heat Treatment. By Denison K. Bullens, consulting metallurgist. 441 pages, illustrated, 6 in. by 9¼ in. Bound in cloth. Published by John Wiley & Sons, Inc., New York City. Price $3.75.

Doctor Bullens in the first paragraph of the preface to this book says: "Modern heat treatment should be considered as an art or trade, since it certainly requires knowledge, skill and judgment for its proper performance. These, in turn, necessitate at least some knowledge of heat, of steel, and of the effect of heat upon steel. And all three factors are linked together by the 'human element.'" The human element does play a very large part in the proper heat treatment of steel, but unless supplemented by some knowledge of the change made in the structure of the steel by the heat, the man who relies wholly upon his judgment based on past experience will not produce the results nor meet new conditions as well as he who links his experience with the information obtained from scientific study, or theory, if you like, of the effects of heat on steel.

The author has given in an interesting and understandable way the fundamentals of the structure of steel, how this structure is changed by the addition of heat, what the accurate control of the heat means in obtaining the proper results and what effect the various alloys have on the steel and the method in which they should be handled. His discussion is not limited to the scientific phase of the problem entirely. Methods for obtaining the different steel characteristics are thoroughly described. The book is well illustrated and contains information that men who are interested in heat treated metals should know.

Combustion in the Fuel Bed of Hand-Fired Furnaces. By Henry Kreisinger and others. 76 pages, 6 in. by 9 in., illustrated. Bound in paper. A technical paper, No. 137, issued by the Bureau of Mines of the Department of the Interior.

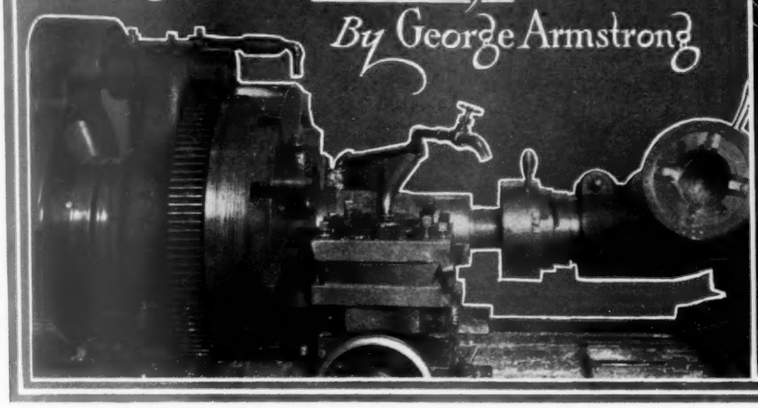
The object of the investigation of which this book is a record was to determine the conditions governing the processes of combustion in the fuel bed of a hand-fired furnace, to furnish data for the correct design of coal-burning grates and furnaces and their efficient operation. The results also cast light on the problem of clinker trouble as related to fusibiltiy of ash and indicate the possibility of a higher rate of gasification of coal in gas producers.

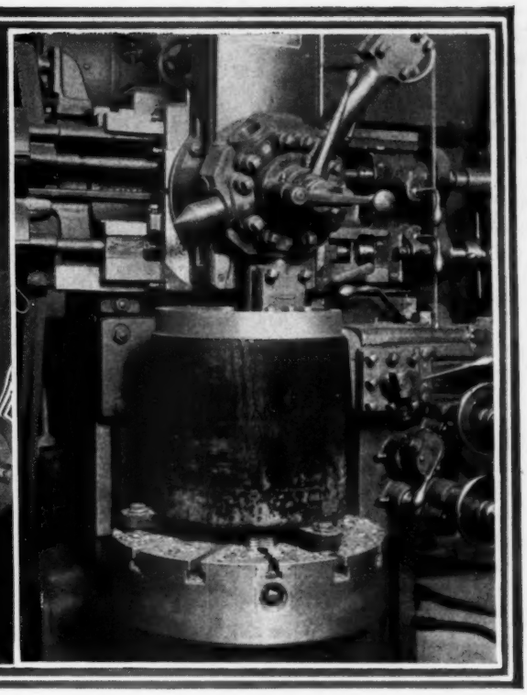
The report contains general information on the combustion of coal in furnaces and describes the results of numerous tests made in an experimental hand-fired furnace which was designed for an accurate study of the processes of combustion in the fuel bed.

Centralized Production Of Locomotive Repair Parts

Large Economies May be Effected

By George Armstrong





WITHIN recent years quantity production of locomotive and car repair parts at a central point for distribution over the system, has received more and more consideration as an effective means of combating increasing maintenance costs. Several large railroad systems have installed manufacturing departments in conjunction with the larger repair shops, in which are made many parts susceptible to partial or complete standardized finishing. This system manufacturing, or centralized production, as it may better be called, has been and should be much more effective in reducing the cost of many articles, especially those which are required in considerable quantities.

The success of the modern manufacturing industry depends largely upon organization, specialized division of labor, and adequate facilities. While the problem of centralized production cannot be applied to car and locomotive repairs on the same scale as in a manufacturing plant its successful application depends upon the same factors.

The aim of centralized production should be not only economy, but control so that:

The *right thing* is done at
The *right time* in
The *right manner* so as to effect
The *right result.*

The right result to be secured should be:

(1) Reduction in the cost of the articles produced.
(2) Prompt distribution of output.
(3) Effective distribution of output by eliminating waste due to the use of improper materials or excessive disbursements.

The essentials for successful centralized production are:

(1) A well defined policy on the part of the management as to scope of the work relative to other parts of the organization and operation.
(2) An adequate organization.
(3) Proper equipment.
(4) Effective records.
(5) Systematic "follow up."

Without a well defined policy as to the scope, etc., of the centralized production department, a decided handicap is ever present, militating greatly against the success of the effort and prohibiting the attainment of the best results. From the very inception it must receive the constructive co-operation of the management. A thorough realization of the object to be attained should dictate the necessity for divorcement from any repair shop activities and the development of centralized production as an entirely separate and distinct feature under the immediate direction of the stores department and the superintendent of motive power.

An organization is the machine by which the forces of industry are directed. To be effective, it must embody control. To secure control it must be centralized. Not only centralized, but definite. The objective, dependable output at a substantially reduced cost, demands that the head of the centralized production department be wholly unhampered by needless links in his chain of responsibility, source of supplies, or distribution of product.

Manufacturing is inherently different from repair work, and consequently demands an organization fitted to it and not merely a modified locomotive repair organization, as an integral part of some repair shop. Successful manufacturing is the result of proper utilization of economic principles, division of labor, quantity production, and systematized cost accounting. Railroad repair work, as the name denotes, is a repair proposition and while it embraces a plane between manufacturing and job repair work, it is only to a limited extent capable of utilizing labor division, and except for those articles adapted to centralized production is wholly devoid of opportunities for quantity production.

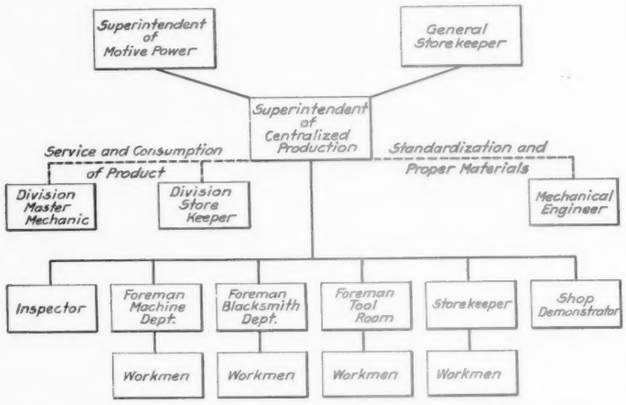
If this is true, it follows that the best service will be secured in centralized production with an organization competent to develop and direct a corps of workmen having a definitely divided field of labor due to quantity production. This in conjunction with a cost system adapted to the needs will provide ready and accurate knowledge as to the advisability of continuing to manufacture any article or of purchasing it. The organization chart shows the ultimate development of the centralized production department. Little comment is required as to the duties of the various staff members, except the inspector and shop demonstrator.

The output should be rigidly inspected before being transferred to the storehouse, and in many instances during the process of manufacture so as to detect defects when first disclosed and avoid the expenditure of unnecessary labor. Am-

ple facilities as to limit gages, hydraulic test pump for steam fittings, etc., should be provided. Definite procedures should be established for inspection, recorded in a card file and revised as found necessary, so that defects located in service, etc., may be checked before the material is shipped.

The shop demonstrator should be responsible solely for the machine output. He should instruct new men, follow up work on any new articles, develop the best set-ups and machinery procedures, and time operations for piece work prices or premium time.

Maximum economy will not result if a follow-up inspection is not provided to investigate the service given by the various materials and the quantity consumed. The records should be such that accurate knowledge will be available as to the consumption at the various points, and at any indication of excessive consumption the superintendent of centralized production, or one of his staff, should investigate and in conjunction with the division master mechanic endeavor to locate the cause; i. e., improper material, poor workmanship, improper maintenance, faulty design, etc. Many of the large railroad supply companies, dependent upon their sales for existence, follow up the service of their products so that the railroads will receive the best service at the lowest maintenance cost. Is it not equally as important that a railroad should carefully follow up the service of material which it manufactures for its own use?



Organization Chart for Centralized Production Department

Another equally important factor is the assistance which the superintendent of centralized production may render in standardizing parts of equipment. Responsible as he is for the manufacturing facilities, he should be well equipped to advise and study the possibilities of standardization, and the essentials for producing the standardized parts. When sweeping changes are required, as in the equipping of locomotives with clear vision windows to comply with the Federal inspection act, and the making of grab irons, handholds, etc., for compliance with the Safety Appliance Act, the organization, facilities and experience of a centralized production department may be of inestimable value.

Little need be said about the actual equipment and scope of the centralized production department as this has been covered fully in various articles appearing in the past.* However, care should be exercised to equip the plant with the best machine tools adapted for the work, and which the quantity of work to be done will justify.† While, of course, the installation could be made in buildings formerly used for shop purposes, the best method would be to erect suitable buildings, so planned as to give unidirectional flow of material, ample room for expansion, with raw material at one end, finished products at the opposite, and a floor suited for the operation of elevating trucks and loading platforms at the car floor level. Heavy material should be so grouped that it may be carried from the stock yard to the machine tools by means of a traveling crane.

PATT. NO. Am 1691 | CARDS / CARD NO. | 1½" B. & O. | CARD 4711

Chuck blocks C-13
1. B-31
2. B-24
3. H-23 ¾" Shank Centering Drill
4. H-105 7/16" Twist Drill
5. H-50, H-16 ½" Std. Tap (first)
6. Die Head #30123-G 2⅜-10 thd.
7. ½ x 1" Parting Tool
8. ½ x 1" Flat nose turning tool

ORDER	REF.	OPERATION	TOOL	GAGE	SPEED	FEED	CUT
1.	A	Chuck- Rough turn body	1				
2.	B	Face back of flange and nick for thread clearance	7				
3.	A	Finish turn body to 2⅜	8				
4.	C	Chamfer edge of body	2				
5.	D	Center for drill	3				
6.	D	Drill	4				
7.	D	Tap	5				
8.	A	Thread and remove	6				

Instruction Card Showing Tools to Be Used for a Particular Job

The scope of centralized production embraces a large variety of articles which can be produced at a substantial reduction, in quantities, from the cost at which they can be produced locally with inferior facilities. By no means should the field of highly specialized industry be invaded without a thorough cost analysis, taking into consideration besides

Pattern or Shape No. Am 15063

Disbursements Ordered			Disbursements Filled					Totals			Disbursements Ordered			Disbursements Filled					Totals		
Date	Req'n	Q'ty	Date	Q'ty	Inv. No.	Price	Amount	Month	Q'ty	Amount	Date	Req'n	Q'ty	Date	Q'ty	Inv. No.	Price	Amount	Month	Q'ty	Amount
1916	C311-54		1917																		
11-12	K110-5	75	2-20	75	49164	.123	9.23														
11-20	BW12-1	100	2-20	100	49165	.123	12.30														
12-5	J120-24	6	2-20	6	49166	.123	.74														
12-8	RSS120-24	200	2-20	100	49167	.123	12.30														
12-8	K12-12	250	2-20	125	49168	.123	15.38														
12-20	X1-72	75	2-20	75	49169	.123	9.23														
1-5	C311-54	300	2-20	100	49170	.123	12.30	Jan.	581	71.48											

Form for Checking Distribution and Consumption of Products

* *Railway Age Gazette, Mechanical Edition*, 1914, page 593; and Betterment Briefs by H. W. Jacobs.

† *Railway Mechanical Engineer*, February, 1916, page 89.

those factors actually absorbed in the plant accounts (power, plant supervision, tools, non-productive labor, etc.) the larger factors taken up in other accounts (department supervision, depreciation, interest on investment, etc.,) and which are real costs and included in competitive industries' costs of production. Even though a profit is still shown, an analysis should be made of the intangible factors among which may be mentioned traffic relations with shippers, interdependence of industry and transportation, etc., before it is decided to manufacture.

Water glass fittings, gage cocks, oil cup parts, cylinder packing rings, valve packing rings, cylinder cock parts, boiler checks, fusible plugs, driving boxes, shoes and wedges, piston valve parts, slide valves, bolts, grab irons, drop-forged crank pin collars, crosshead and knuckle pins, crossheads, brake connection rods, large castle nuts, piston rods and countless other articles will present themselves for consideration.

An adequately equipped toolroom for maintaining, storing and making the necessary tools is an important feature which must not be overlooked. Limit gages, check gages, and, if possible, a Johanusson standard gage set should be part of the equipment. A system should be developed for storing tools, so that they are readily available. Tools should be marked with a key letter and serial number and storage space provided so as to definitely locate all tools. An instruction card, such as is shown in one of the illustrations, should be provided for information in getting tools together for a job; it will also serve as a guide to the operator if he is unfamiliar with the job.

The routine of handling and filling orders should be simple, yet consistent with an accurate, readily accessible record for checking distribution and consumption of the product. One of the forms illustrated is well adapted for such a record. As each requisition is received, after checking to see if correct, the various items are transferred to the respective cards. Thus a record is available at any time showing the material due at any point on the system, as well as the date the order was received. When material is shipped, applying on the requisition, it is recorded on the card, directly opposite the order, together with the date and invoice number. If, for any reason, the order cannot be filled in its entirety, the balance due is recorded below in red and is further checked against in shipping. Thus orders can be filled in order of priority and a complete condensed record is available for reference.

Pattern or Shape No. Am 15063 — Maximum / Minimum

Raw Material												Delivered to Shop		Finished Material							
Ordered		Received												Delivered in Stores				Disbursed			
Reqn.	Qty	Date	Qty	Wgt	Consignor	Reqn.	Order or Inv. No.	Price	Amount			Qty	Amount	Date	Qty	Price	Amount	Date	Qty	Amount	
10-46	300	11-15	200	260	Am. Mall. Cast Co	10-46	—	.065		13	00	700	45 50	2-15	700	.123	86 10	Jan. 17	581		71 48
12-55	2000	12-18	100	132	" " "	10-46	—	.065		6	60			3-1-17	119	.123	14 62				
		1-2	400	518	" " "	12-55	—	.065		25	90										

Master Record (Monthly) of Material for Centralized Production Plant

4-25 1917

Deliver to Mach 730 by 3 p.m. 4/25
from Storehouse
600 am 18003

Make
600 am 18003
Cd. 15110

Raw Stock Del'd		Finished Pieces	
4-25	200	To St. H.	598
4-26	400		
		Def. Pcs.	2
		Scrap	—

Note cause for rejection of raw or finished material on back

J.M.
Inspector

Work Scheduling Ticket

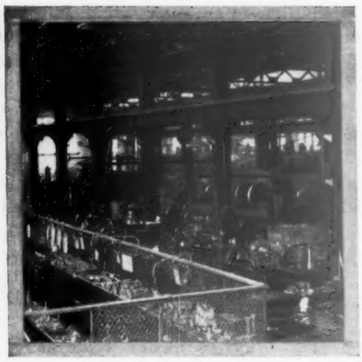
Each month the disbursements are totaled and entered on a master record, which is illustrated. This card shows the amount of raw material on order, on hand, disbursed to shop from storehouse, receipts of finished stock from the storehouse and the monthly balance in red of both raw and finished material.

The storehouse man makes a weekly check of material which is getting low and this is checked with the master card to see that raw stock is available, and this item, judged from past consumption and the amount due, should receive preference in manufacturing. Each month also, as the cards are balanced, the clerk makes a note of those showing a small balance and these are also at that time checked for scheduling.

Work scheduling in the shop is effected by the use of a ticket which not only serves as an order for the raw material and a complete direction for the work, but also as a permanent record of the material used and its disposition.

A daily receipt is secured from the storehouse of all finished material delivered from the shop. This, combined with the data on the work schedule slip and labor performed by the piece work or premium system, affords a good foundation for cost accounting.

With an organization exercising centralized control, supported by accurate, reliable records, and aided by a thorough follow-up inspection, and backed by a conviction on the part of the management that manufacturing or centralized production is quantity production and demands a division of labor and must be treated as a manufacturing industry apart from equipment maintenance, unquestionably large economies are possible in the production of many parts required in locomotive and car maintenance.



SELECTION OF MACHINE TOOLS

BY WILLARD DOUD*

THE character of machine tool equipment is one of the principal items which determine the quality and quantity of work turned out by any railroad shop. Aside from efficient supervision and labor and good materials, it is perhaps the most important factor in producing the results which are sought after by every railroad executive and by which the ability of every mechanical department official must ultimately be judged. In spite of the importance of good machine tool equipment in a railroad repair shop, the statement may be made without reflecting in any way on those responsible for the selection of machine tools, that too little attention is given to the details of their selection.

As a general rule, the kind and number of tools required originate with the local officers having supervision over the various shops of a railroad. Sometimes the make is specified and the list of tools wanted is submitted to the proper motive power official for his approval. Careful scrutiny of a large number of tool lists prepared by local shop officers, generally will show well diversified opinions as to the character of the machine tools required for the same class of work.

To obtain more satisfactory results in the selection of machine tools, some railroads have appointed a special man to supervise the work of selection and distribution and on one large railroad, a machine tool committee composed of two shop superintendents, an assistant purchasing agent and the superintendent of piece work, approves all tool lists and selects those to be purchased. Experience on one railroad where tools were selected by a supervisor of tools and on another by a tool committee, has convinced the writer that better and more satisfactory results to all concerned are obtained where the work is handled by a committee. One of the reasons why better results seem to be obtained with a committee is that the viewpoints of more than one individual are obtained as to the merits of tools and their suitability for a certain class of work. Also a local shop officer will, as a rule, feel somewhat better satisfied when the make of tool purchased differs from the one asked for in his original list if the change is based on the opinion of a committee of experienced men instead of that of an individual, no matter how experienced the individual may be.

Machine tools, excepting those of the bench variety and possibly the simpler forms of grinders and drills, represent considerable investment even under normal conditions and especially at the present time. This being the case, every precaution should be taken to make sure that the machine selected is exactly fitted for the work to be performed, well constructed and in every way a facility for giving the best results from both production and maintenance standpoints.

In discussing the matter of selecting machine tools with the superintendent of shops of a large railroad system some time ago, the statement was made that practically all of the tools purchased for his shop were selected from catalogs. That such a procedure was somewhat common may be gained from the presence of the formidable catalogs, issued by large manufacturers of machine tools for railroads, which may be found in practically every shop office. These are fine examples of the ability of the illustrator and printer to produce well constructed picture books, essentially lacking in detailed descriptions of the tools illustrated. This statement is not made with the idea of minimizing the importance of using machine tool catalogs, in fact they are very important and necessary in the process of determining the type and character of the tools to be selected.

In making up a list of machine tools, free use should be made of catalogs and the fact kept in mind constantly that no one manufacturer makes all, or even the greater portion of the machine tools which are suitable for use in railroad shops. The entire list of manufacturers' catalogs, descriptive of the various tools to be purchased, should be examined in detail and if these are not available, the writer knows of no better source of information than the advertising pages of the trade journals of the railroad, iron and woodworking industries.

When a decision is reached as to the types of tools best suited to the local conditions, detailed specifications for the equipment should be prepared and sent out to manufacturers and jobbers. The preparation of specifications for machine tools is a point which is often neglected by railroads and a little time and care spent in their preparation will yield good results by making the purchasing and selection easier, surer and simpler for all concerned. The writer has used the following form of specifications in his work for some time past with good results and has selected for example the details covering a 36-in. motor driven engine lathe, together with some proposal and other requirements which accompany and form part of the specifications.

METHOD OF SUBMITTING PROPOSALS

In submitting proposals on the machine tool equipment listed in the following pages, attention is called to the following requirements which must be adhered to without variation:

1. In case the bidder does not quote on the make of the machine specified, the quotation shall cover equipment which the bidder considers equal to that specified.

2. Information covering details of each machine specified must be furnished exactly as shown in the list under each item, variation being allowed only to cover special features, of the machine quoted on, which are not contained in the specifications.

3. Where equipment is to be furnished, it must be furnished in entirety or exceptions must be noted as to any omissions.

4. Each item must be considered separately and in no event shall it be included in the same proposition with any other item.

5. The net weight of each machine shall be given.

6. Guaranteed time required for delivery of each machine must be stated specifically.

7. A print, photograph or illustration showing the prin-

* Consulting Engineer, Chicago, Ill.

cipal construction characteristics and other necessary information shall be submitted with and attached to a separate sheet bearing the item number. (An example of the specifications of one engine lathe, Item 27, is shown herewith.)

8. As the railroad company may elect to purchase all electric motor equipment and deliver it to the works of the machine tool manufacturer for application, each item where motors are necessary for the operation of machine shall give the following information in full:

a Make and type of motor.
b Frame number and speed of motor.
c Make and type of controller or starter.
d Deduction for purchase of electrical equipment by the railroad company, with delivery f. o. b. machine tool builders works and additions charged, if any, for application to the machine tool.

Unless otherwise specified, the price of each alternating current motor 7½ h.p. and larger, shall include a two point

Item 27. One Engine Lathe.

Nominal size	30 in. by 14 ft.
Make	American
Catalog reference	American Tool Works Co. No. 40
Application	General Locomotive Work
Length of bed	14 ft. 0 in.
Length between centers	8 ft. 3 in.
Swing over wings of carriage	32½ in.
Swing of carriage bridge	22¾ in.
Diameter of hole through spindle	2 9/16 in.
Size of tool	1 in. by 2 in.
Taper of centers	Morse No. 5
Diameter of small face plate	15 in.
Diameter of large face plate	30½ in.
Diameter of spindle nose	5 in.
Threads per inch on spindle nose	2
Number of spindle speeds	12
Range of spindle speeds, r. p. m.	6-260
Diameter of lead screw	2¼ in.
Threads per inch on lead screw	1
Number of feed changes	48
Range of feed changes, cutting	5-280
Range of feed changes, threads per inch	½-28
Type of rest	Compound
Travel of compound rest	9 in.
Kind of drive	Motor
Current and voltage of motor	Alternating, 440 volts
Type of motor	Slip ring, constant speed
H. P. and speed of motor	10 hp. 1200 r. p. m.
Frequency of motor	60 cycles
Type of motor control	Reversing wheel mounted on carriage

In addition to the special wrenches and other tools necessary for operation of machine, the following equipment shall be furnished: One steady rest; one follow rest; full swing rest attachment; taper attachment; thread dial attachment, and one 24-in. combination universal and independent "Wescott" chuck, threaded to fit the spindle.

auto-starter or compensator with no-voltage release attachment. The necessary controller equipment shall be included in the price of direct current motors.

9. Failure to comply with any or all of the above requirements may result in no consideration being given to the item or items in which omissions or variations occur.

Protection of Hazardous Parts.—Special attention is called to the desirability of having effective protection on all gears, belts, or other rapidly moving parts which may be considered as hazardous to the machine operative or other employees. All protective devices shall be of neat design and shall be made and applied at the shop in which the machine is manufactured. Effectiveness, accessibility to parts protected, permanency and neatness of the design will be the points considered is judging the merits of protective devices. Other things being equal, the machine giving the most effective protection to operatives and others will be given preference.

The protection furnished shall satisfy all requirements of the State Department of Factory Inspection and any adjustments or additions to the machine proper, necessary to meet these requirements, shall be made at the expense of the machine tool builder.

Services of Demonstrator.—In the price of machine tools of a special nature shall be included the services of a demonstrator for a sufficient length of time to fully acquaint an employee of the railroad company with all details of operation of the machine. The quotation shall state the length of time the demonstrator is to remain in the company's shops and no rate per day and expense basis will be considered in this connection.

The question may arise as to the necessity of going into such detail in the purchase of machine tools and the inclusion of a tabulation which is practically a copy of information obtained from the manufacturer's catalog; also as to the policy of specifying definitely the product of any one manufacturer.

To answer the first part of this statement, it may be said that the detailed description of the lathe includes all items which are of importance in considering the various machines offered for purchase and that a basis is established for assuring the same information being given for each of the various makes of tools. Uniformity and completeness of the information regarding the various tools is of immense value in comparing the quotations of the different makers and renders the tabulating of bids by the purchasing department, not always too well acquainted with the details of the machine tools, more or less of a mechanical procedure. As to the question or propriety of specifying the machine of any one manufacturer, this point is fully covered in Clause 1 of the above requirements and as all tools of a general character, such as lathes, planers, drills, millers, punches, shears and hammers are built along the same general line and possess all of the features mentioned in the tabulation, there appears to be no logical objection to using any one make of tool merely as a reference standard.

It is a rather difficult matter at times to decide what make of tool is best suited to certain conditions, even when all the data and information concerning the tool have been received from the manufacturer. A plan which has been found productive of good results on one large railroad in particular, noted for the care taken in the selection of machine tools, is for the tool committee or the supervisor of tools to visit other shops where similar tools are in operation in case there is any doubt as to the entire suitability of the equipment offered for consideration. While such trips of inspection may seem entirely unnecessary to some and a waste of time, the railroad in question has found them a paying investment, as certain features of construction which may look very desirable when seen in a photograph or in a catalog illustration, give an entirely different impression when seen on the actual machine in operation.

Another desirable feature of the inspection trips is that those making them see what the other fellow is doing and generally are sure to note methods which can be adapted to their home shops with profit.

There is a tendency at times to favor the installation of large tools in railroad shops when such tools are not entirely suited for repair shop service, except for certain conditions. Unless the tool is to be installed in a large shop of a large railroad system, and there is a great amount of manufacturing work to be performed, the installation of large planers, multi-head frame slotters and drills with large bed plates, multi-spindle cylinder boring machines and large hydraulic presses of the four post type, should be considered very carefully and the results expected from their operation weighed against those which may be obtained from smaller and more flexible separate units capable of performing the same class of work.

The multi-head tool with its large bed plate occupies valuable space in any shop and in the case of one shop which the writer has in mind, the better production results obtained from the installation of a multi-head frame slotter are more than neutralized by the obstruction which the bed of the tool offers to the handling of materials to and from the other machines and through the shop. Large tools of the types mentioned present a formidable appearance in a railroad shop, but in a large number of instances are "monuments"

to the questionable judgment of the officer responsible for their selection.

A point of importance in the selection of machine tools for railroad shops which must not be lost sight of is that a certain type of tool which is suitable for one railroad may not be suitable for another road for the same class of work. Modern machine tools of the better class are designed to meet conditions which exist in shops where production is pushed to the limit. Where shop labor conditions are such as to limit the production of a machine as compared with its possibilities where there are no restrictions, the more expensive type of machine is not always justified. A simpler and lighter machine will meet all requirements fully as well with a lower investment in the tool.

The number of points which should be considered in the selection of machine tools for railroad shops are legion, and other things being equal, the best service results will be obtained where the greatest degree of care has been exercised in the selection of a machine to meet certain shop conditions and to perform a certain class of work.

Power Tests of Machine Tools

Determinations of Average and Maximum Driving Power And Power Wasted by Friction, Made on the N., C. & St. L.

BY C. H. CRAWFORD
Assistant Engineer, Nashville, Chattanooga & St. Louis

THERE is a great amount of data available regarding the original cost and the cost of operation of individual motor drive for machine tools in new shop installations. However, comparatively little information can be found concerning the substitution of individual motor drive for group drive in existing shops, and with a view to securing data on this subject the tests described below were conducted.

At the present time the Nashville, Chattanooga & St. Louis has a large number of tools in its machine shop at Nashville which are driven in groups from line shafting run by electric motors. In the planing mill the machinery is also driven by line shafting, the power in this shop being furnished by a steam engine. It was thought that a saving could be effected by the substitution of motors for the planing mill engine, and as group drive could not be applied readily, individual motor drive was considered. This brought up the question of the advisability of changing the tools in the machine shop also from group drive to individual motor drive.

The problem which was investigated in this case is one with which engineers are often confronted and the details of the method show a practical way to arrive at a logical solution, while the results obtained may be of interest as an indication of what might be expected under similar circumstances. The prices of the motors in the tables were secured sometime ago and would now be somewhat higher, but since there has been a corresponding advance in the cost of fuel and wages, the change will not affect the results to any great extent.

In the particular cases under consideration the factors which made the adoption of individual motor drive seem advisable were, the possibility of saving by having a centralized power supply, the elimination of losses due to the friction of shafting, which took place whether the shops were running under full load or not; increased output of machines made possible with motor drive, greater reliability and greater safety. Owing to the high first cost of motors it was considered best to group some of the smaller machines so that several could be driven by line shafting from one motor.

There seemed to be no doubt but that individual motor drive would give better results from the standpoint of shop operation, and in determining the advisability of making such an installation the question to be decided was whether the saving in power and labor would justify the investment required. For the purpose of ascertaining the economy which would be effected by the change tests were conducted on practically all the machine tools in the shops, the friction horsepower, the maximum and the average horsepower under load and the starting torque at maximum load being determined. The power required to drive the shafting was determined separately. The power used by the groups of machinery in the shop was measured by inserting a polyphase graphic recording wattmeter in each circuit and taking records, as shown in Fig. 1, for from three to six days in succession in order to get a fair average of the power consumed.

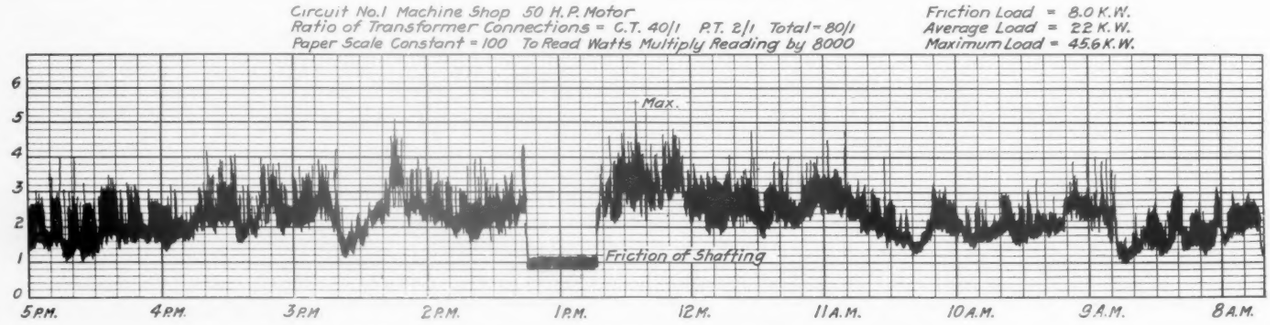


Fig. 1—Sample of Chart Taken in the Shop Power Tests on the N. C. & St. L.

The chart which is reproduced was taken on one of the power circuits in the machine shop and shows the variation in the power consumption during one working day. The record for the morning is on the right hand side and that

for the afternoon on the left hand. Between the two is the record for the noon hour which represents the friction of the shafting only. It will be noted that while the maximum load was 45.6 kw. and the average only 22 kw., the friction

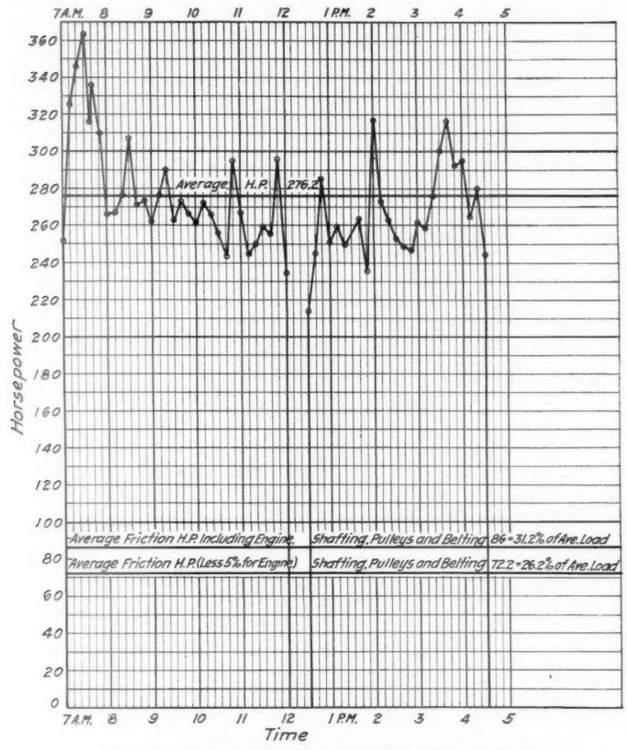

7A.M. 8 9 10 11 12 1P.M. 2 3 4 5
Horsepower
Average H.P. 276.2
Average Friction H.P. Including Engine. Shafting, Pulleys and Belting. 86 = 31.2% of Ave. Load
Average Friction H.P. (Less 5% for Engine) Shafting, Pulleys and Belting. 72.2 = 26.2% of Ave. Load
Time

Fig. 2—Horsepower Chart for the Planing Mill

load was as much as 8 kw. or 36.4 per cent of the average load.

The power used by the planing mill machinery was found by taking indicator cards from the engine at intervals of ten minutes, from which the horsepower was calculated and a curve of horsepower for the day plotted, as shown in Fig. 2.

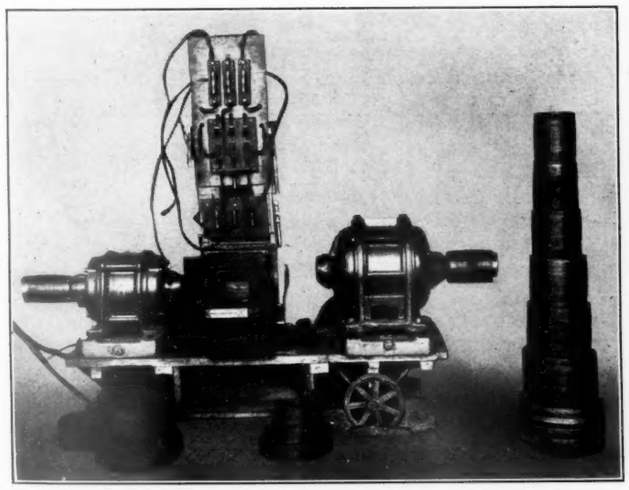


Fig. 3—Portable Motors for Testing the Machine Tools

It will be seen that in this shop also there was a large amount of power wasted in friction and windage of shafting and belts.

In testing the machine tools in the shop three motors were used, one of 5 hp., one of 10 hp. and one of 25 hp. To facilitate the work of testing the 5-hp. and 10-hp. motors were mounted on a truck, as shown in Fig. 3, with the control apparatus between them. The wiring diagrams for the motors are shown in Fig. 4. The shafts of these two motors were fitted with bushings of the same outside diameter and

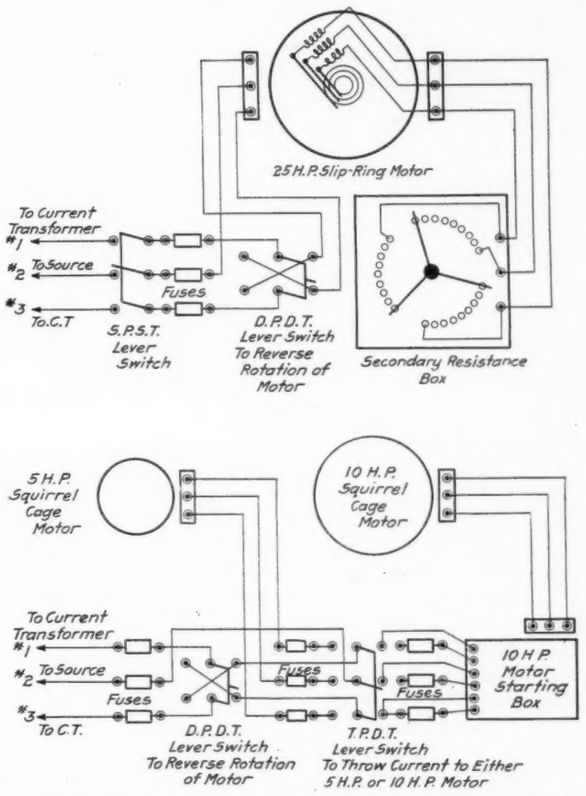


Fig. 4—Wiring Diagram of Motors Used to Determine the Horsepower Required by the Machine Tools

having keyways so that wood pulleys ranging from 5 in. to 14 in. diameter could be used on either motor. The electrical apparatus for recording the power input to the motors

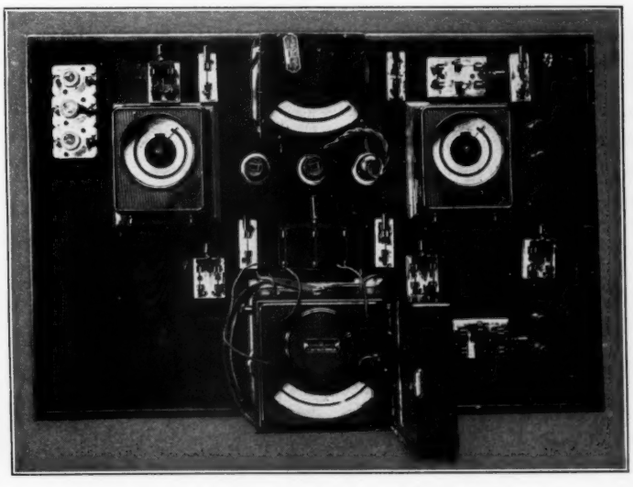


Fig. 5—Plan View of the Meter Table

was mounted on a portable table. The plan view of this testing table is shown in Fig. 5, while Fig. 6 shows the method of wiring instruments. A record of the machine was taken on a form which provided for general data concerning the machine as well as the results of the test and the method of connecting the motor which was best adapted to each tool. The

data taken on the test of the individual machines included the friction horsepower and the average and the maximum horsepower while the machine was in operation. To assist in selecting the type of motor best suited to the machine the starting torque was measured by attaching a lever to the driving shaft of the machine and moving it by a pull on the lever at a fixed distance from the axis of the shaft, the force required being measured by a spring balance.

the shop was working was found to be 59.6 hp. The friction load of the shafting and belts was 35.2 hp., or 37 per cent of the average gross load of 94.8 hp. In the planing mill the average gross indicated horsepower was 276.2. The friction horsepower of the engine, shafting, pulleys and belting was 86 hp., or 31.2 per cent of the average gross load. Allowing 5 per cent for the engine friction gives 72.2 hp. for friction of the shafting, or 26.2 per cent of

TABLE II—SUMMARY OF TESTS ON MACHINE TOOLS AND COSTS OF MOTOR DRIVES.

Description of machine.	Shop No.	Friction H.P.	Average H.P.	Max. H.P.	Starting torque.	Description of load.	Test motor H.P.	Test motor Belted to	Motor recommended H.P.	Motor recommended Type.	Motor recommended Speed.	Type control.	Cost of motor.	Cost of control.	Installation and change in machine.	Total cost.
22 in. cut-off saw	A1	0.5	2.8	3.4	22	3 in. diameter steel	5	CTR	5	SCCS	1,200 GM	IM	$97	..	$20	$117
Power hack saw	A2	(too small to test successfully—group with G4 and E6)							2	SCCS	1,800 GC	IM	54	..	15	69
Boring mill	B1	0.8	5	5.6	24	¼ in. cut by 3/16 in. feed (inside)	10	CTR	5	DCAS	1,800 GM	PBA	265	$81	20	366
50 in. boring mill	B2	(similar to B3 for power)							5	DCAS	1,200 GM	PBA	265	81	20	366
44 in. boring mill	B3	0.7	4.6	4.9	56	3/16 in. cut by 1/24 in. feed (cast iron)	5	M	5	SCCS	1,800 GM	IM	76	..	20	96
Cylinder boring machine	B6	0.8	2.8	5	135	3 tools 5/8 in. to 7/8 in. cut, 3/64 in. feed	10	CTR	5	SRVS	900 GM	IM	162	..	35	197
Taper bolt machine	C1	(could not test: estimated)							5	SCCS	1,800 GM	IM	76	..	20	96
4½ by 6 ft. radial drill	D1	0.1	2	2.1	22	1 25/32 in. hole (wrot iron)	5	MC	2	SCCS	1,800 GM	IM	54	..	15	69
26 in. by 40 in. radial drill	D2	(similar to D1)							2	DCAS	1,800 GM	PBA	120	70	15	205
24 in. by 4 ft. 8 in. radial drill	D3	1.4	2.1	2.2	..	1 13/16 in. (steel)	5	CTR	2	DCAS	1,800 GM	PBA	120	70	15	205
18 in. by 20 in. drill press	D6	(could not test: estimated)							1	SCCS	1,800 GM	IM	45	..	15	60
24 in. by 48 in. radial drill	D10	1	1.5	..	..	1 13/16 in. hole (wrot iron)	5	M2	2	SCCS	1,800 GM	IM	54	..	15	69

KEY TO ABBREVIATIONS.

CTR—Countershaft overhead. MC—Countershaft on machine. M—Belted directly to machine. SCCS—Squirrel cage, constant speed. DCAS—Direct current, adjustable speed. SRVS—Slip ring, varying speed. IM—Included with motor. PBA—Push button automatic. GM—Geared directly to motor. GC—Geared to countershaft.

NOTE—The starting torque was taken at the machine shaft.

From the data thus secured it was possible to select the type of motor which should be applied to each machine tool and the cost of the motor, including installation on the machine, was determined. With these data and the saving in power known it was possible to calculate the saving which could be effected by the use of individual motor drive. The following are the results of the tests made on some typical machines:

TABLE I.

Description	Friction Hp.	Average Hp.	Maximum Hp.	Description of load
90-in. wheel lathe	4.5	17.0	19.5	⅜-in. cut, 1/16-in. feed
36-in. engine lathe	0.4	5.6	6.8	⅜-in. cut, 1/32-in. feed, steel
22-in. engine lathe	0.3	3.0	4.3	3/16-in. cut, 1/32-in. feed, cast iron
Double head axle lathe	1.2	11.8	14.3	⅜-in. cut, 1/16-in. feed, steel axle
3-in. turret lathe	0.7	1.3	2.6	13/16-in. bolts
26-in by 8-ft. planer	1.9	4.3	5.6	5/16-in. cut, 1/16-in. feed, cast iron
48-in. by 12-ft. planer	0.8	4.6	11.7	¾-in. cut, 1/32-in. feed, cast iron
28-in. draw cut shaper	0.2	3.5	4.5	⅜-in. cut, 1/32-in. feed, cast iron
Wheel boring mill	0.6	7.1	7.7	¼-in. cut, 3/32-in. feed, cast iron wheel
44-in. boring mill	0.7	4.6	4.9	3/16-in. cut, 1/24-in. feed inside; ⅛-in. cut, 3/16-in. feed outside, cast iron
Cylinder boring machine	0.8	2.8	5.0	3 tools, ¾-in. cut, 3/64-in. feed
18-in. by 30-in. slotter	..	4.0	4.9	¼-in. cut, 1/64-in. feed, wrought iron
24-in. by 4⅛-in. radial drill	1.4	2.1	2.2	1 13/16 hole, steel
Emery wheel	0.4	2.4	..	Dressing lathe tools
Hydraulic press	0.9	4.4	..	Pressing on tank wheels
Hydraulic press	0.6	4.3	5.6	Pressing off driving wheels
22-in. metal cut-off saw	0.5	2.8	3.4	Cutting 3-in. diameter steel
PLANING MILL				
16-in. by 20-in. sill dresser	4.0	9.5	23.0	Cutting one side oak, 2½ by 8-in. to 1⅞-in by 8-in.
Timber sizer	29.0	48.0	62.0	Cutting four sides
Double surfacer planer	8.5	19.5	21.0	1¾-in. by 10-in. oak
Hollow chisel mortiser	4.0	5.9	14.2	2-in. chisel, 4-in. deep
Wood turning lathe	0.1	1.3	..	5-in. diameter piece
Band saw 5-in	8.5	18.0	24.0	Cutting 10-in. oak
16-in. rip saw	1.2	8.0	8.6	Cutting 3-in. oak
16-in. cut-off saw	1.2	6.3	..	Cutting 1¾-in. oak

From the records of the individual machines a summary was made as shown in Table II.

SUMMARY OF TESTS AND COSTS OF MOTOR DRIVE.

In the machine shop the net average power required while the average gross load. Assuming 85 per cent efficiency for the individual motor drive, an average of only 293 hp. would be required for the machine shop and planing mill, a saving of 78 hp., or 21.1 per cent.

From the data given above the investment required to change the machines to individual motor drive was cal-

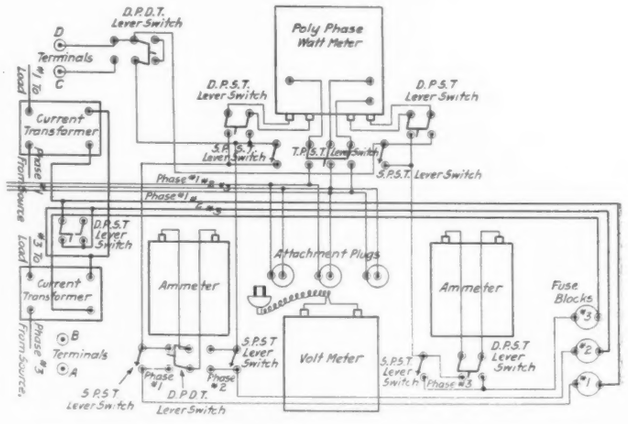


Fig. 6—Wiring Diagram of the Portable Electric Meter Table

culated. To this amount was added that portion of the original cost of the present equipment, less its scrap value, which had not already been provided for in the sinking fund. The fixed charges on this amount were added to the operating costs for the individual motor drive, and this compared with similar figures for the present equipment. The calculated saving in yearly expense after all charges had been met and the costs per horsepower under the present and the proposed system had been considered amounted to 14 per cent on the investment. It will be seen from this that a considerable saving is effected by the adoption of the individual motor drive in this case, aside from that resulting from better lighting and the greater reliability and increased output of the machines.

DEVELOPMENTS IN RAILWAY SHOP TOOLS

A Brief Survey of the More Important Improvements Introduced Within the Past Few Years

COMPARATIVELY few radical improvements have been made in railway shop machine tools and equipment in the past few years. Minor improvements, in the interest of the safety and convenience of the operator and increased output, have been made on many of the standard machines and not a few have been strengthened better to meet the requirements caused by the continued and more extensive use of high speed steel cutting tools. In general the most important development in machine tools has been the tendency toward centralized and more convenient control.

The safety first campaigns have been responsible for innumerable improvements in the direction of making tools and equipment foolproof and as safe as possible. The effect in general has been to secure much neater and more attractive designs and arrangements. Gears are covered over; belts and revolving wheels and parts are boxed in. The use of eye protectors for machinists and grinders, and in some cases helmets for the latter, remind one of the increased value which is being placed upon the human welfare and the fact that the human element is recognized as the vital factor in controlling shop efficiency and output.

Grinding Machines

There have been many applications of grinding on locomotive and car repair work during recent years. Many of the machines were homemade, as is indicated in the article on "Increasing Output and Reducing Unit Costs," which will be found on another page of this issue. There has also been a more general use of the larger and more important types of grinding machines for work such as grinding valve and piston rods, pins, journals, car wheels, and flat work such as guides, etc. There should be still greater use for grinding machines as the railroads give more and more attention to the centralized manufacture of parts. The possibilities of grinding machines in the locomotive shop are indicated by the article in this issue discussing the use of grinding and milling machines at the Juniata shops of the Pennsylvania.

Autogenous and Electric Welding

The introduction of autogenous and electric welding processes in railway repair shops is undoubtedly the greatest single advance which has been made in railway shop practice in recent years. Not a few roads suffered severe disappointment in the early stages of the development of these welding and cutting processes because of a lack of knowledge of the limitations of the various systems and as to the fundamental principles underlying their use. Gradually, however, the difficulties have been overcome, one by one. The competition between the autogenous and electric systems was rather strong at one time and unreasonable claims were made in the interests of each system. As the advantages and limitations of each became better known, however, it was recognized that both could be used to advantage in the same shop, each on the classes of work for which it was best suited.

A typical expression of opinion as to the advantages of the autogenous and electric welding systems in railway shops follows; it is taken from a letter of a motive power officer: "By far the greatest help that has been given to railroad shops, in my opinion, has been the introduction of electric welding and oxy-acetylene welding and cutting. For instance, at ———— we now have five men constantly employed repairing broken or worn parts, many of which would formerly have been sent to the scrap and others repaired by other methods at much higher cost. The practice of welding locomotive tubes to the back flue sheet has practically eliminated the delays and failures to engines on the road due to leaking tubes, and has enabled us to retain a set of tubes in a boiler in heavy service for the maximum period allowed by law—three years—where formerly they would not last more than 18 months because of the frequency of work performed on the firebox end of the tubes. This also results in longer life of tube sheets, many of which were formerly removed because of cracking at the upper flange, due to elongation caused by frequent prossering of tubes."

Milling Machines

A job done on a milling machine may be so accurately and smoothly finished as to require no fitting. Manufacturers find that it makes practically no difference in the rate at which the work is turned out or in the finish, whether ⅛ in. or ½ in. is removed from a heavy casting or forging at one cut. This is an important factor where, as in a locomotive building shop, for instance, it is possible to use the same castings or forgings for several classes of locomotives, with the exception that the amount of material removed may differ for each class. The universal milling machine has always been indispensable in the tool room, but the tendency in railroad shops is to use the other types of milling machine more and more throughout the shop. It has been found, for instance, to give excellent results in such work as machining connecting rods and heavy castings and forgings. A still larger place will be found for the various types of heavy milling machines with the advent of still greater standardization of locomotive parts and the centralized manufacture of these parts.

Articles relating to the use of the milling machine in railroad shop practice will be found elsewhere in this issue. The use of a slab miller for finishing shoes and wedges was described in the *Railway Mechanical Engineer* of March 17, page 147. Those who are especially interested in the efficiency of milling machine cutters may wish to refer to an article on milling machine efficiency by Owen D. Kinsey, tool foreman of the Illinois Central, which was published in the *Railway Age Gazette, Mechanical Edition,* of November, 1914, page 593. A report on milling cutters was presented before the convention of the American Railway Tool Foremen's Association in 1912 by A. R. Davis, of the Central of Georgia. (See *American Engineer* of 1912, page 423.)

Reversing Motor Drive For Planers

Recent years have seen the extensive introduction in railroad repair shops of the reversing motor drive for planers. Because of the severe and peculiar demands on the motors many engineers were skeptical as to the successful application of the electrical drive for this purpose when the first experiements were made not many years ago. Today, however, it is taken as a matter of course and is said to provide not only a better regulation of speed but more accurate stops than where belts are used for driving.

Vertical Turret Lathe

The vertical turret lathe, because of its adaptability and the multiple tool head, is enjoying wide popularity and is said by some locomotive repair foremen to be the best all-around machine tool available. With the use of a universal chuck, such as has been developed in the Richmond shops of the Chesapeake & Ohio and which was described in the *Railway Age Gazette, Mechanical Edition,* of May 15, 1915, page 239, it is possible to machine driving boxes and rod brasses at a rate never before equalled

on any other type of machine, and this is accomplished with ease and convenience. These machines are especially adapted for finishing valve and piston packing rings, cylinder heads and similar jobs, far surpassing the best records which can be made in doing these jobs on large engine lathes or the ordinary boring mill.

High Duty Radial Drill

The more recent and advance types of radial drills that have been introduced are ideal from the standpoint of convenience, quick changes, and wide ranges of speeds and feeds. Today the cutting tool is the limiting factor in production on these machines, rather than the machine itself. If equipped with suitable boring bars and jigs these drilling machines are admirably adapted for boring because of the possibility of making rapid set-ups and changes in the position of the drilling arm.

Automatic Machines for Manufacturing

The railroads, in the interest of economical production, must give more and more consideration to the centralized manufacture of standard parts which may be either completely or partially finished in accordance with the conditions which govern their use. While there has been a decided tendency in this direction it has hardly as yet gotten more than well started. Automatic machines will be more and more necessary as this tendency develops. Set screws and studs can be made from bar stock much more cheaply than on an ordinary turret lathe, while many small parts, such as cylinder cocks, oil cup covers, oil cups, etc., may be made on a chucking automatic.

Milling, Boring and Drilling Machine

The combination milling, boring and drilling machines have demonstrated their usefulness for various types of railroad shop work and with the improvements which have been made looking toward further convenience and facility of operation promise to become still more popular.

Shapers

The shaper has been still further developed to meet the heavy service required of it in connection with the use of high speed tool steel, and in order to hold its own in competition with other types of machine tools. The draw cut shaper has demonstrated its value for railroad shop work and has made possible large savings in those classes of work for which it is peculiarly adapted.

Turret Lathes

Turret lathe manufacturers have given considerable study to railroad shop requirements and this has resulted in special sizes and adjustments to suit the different types of work. The value of these machines has been increased on those roads that have been most successful in the extensive standardization of locomotive parts.

Electric Tempering Furnace

The advantage of an accurate control over the temperatures in tempering tools is so great that the electric tempering furnace should be far more extensively used in railway shops. It has been found, for instance, that a difference in temperature of 50 deg. will practically entirely destroy the usefulness of a tool. The difficulty of determining by observation a small difference of this kind at temperatures varying from 1,000 to 2,000 deg. requires no comment. The problem has been complicated by the introduction of different varieties of high speed steel, each of which requires its own special treatment. The electric furnaces used for tempering tools at the Burnside shops of the Illinois Central were described in the *Railway Mechanical Engineer* of August, 1916, page 423. The Committee on Shop Practice of the Association of Railway Electrical Engineers, in its report for 1915, presented data covering the costs of tempering by means of the electric furnace. These may be found in the *Railway Age Gazette, Mechanical Edition,* of November, 1915, page 590. B. Henrikson, when tool room foreman of the Chicago & North Western at Chicago, presented a discussion on the tempering of tool steel in an electric furnace before the 1912 convention of the American Railway Tool Foremen's Association. This paper was published in the American Engineer of August, 1912, page 426.

Electrically Driven Tools

The ease of control, the possibility of arranging machine tools to the best advantage from a production standpoint without reference to line shafts, and the readiness with which ample power may be provided to suit the requirements for each individual tool, have been responsible for the extended use of individual motor driven machine tools in railroad shops. Where the group drive is used for tools in a new shop the groups are usually small and made up of tools that are operated at one speed or with very few changes of speed; in such cases the group drive is placed where it will not interfere with the operation of the cranes over the heavy machine section.

Reclaiming or Re-rolling Rolls

It is necessary to say but little as to the use of rerolling or reclaiming rolls in railway shops. If recent years have been marked by any radical development in railway shop practice it has been in the movement for the reclamation of scrap material. There has always been a more or less plentiful supply of scrap rod material suitable for rerolling and even though there may not be enough of this kind of work to keep the re-rolling rolls in operation for but a small percentage of the time, it has been a paying investment. In recent months it has been most difficult to buy the smaller size rods from the manufacturers, and some of the roads have secured their entire supply at a reasonable expense by re-rolling scrap material.

Standardized Shop Tools

The output of an individual or of a machine tool may be greatly reduced by the use of improperly designed or poorly maintained tools. This has resulted in the standardization of shop tools of all kinds with special provision for repairing and sharpening them on the part of the tool room forces. Moreover, a very considerable saving has been made in the first cost of these tools by manufacturing them in quantities at a central point and distributing them over the system.

Shop Transfer Trucks

Railway shops, at least the most modernly equipped ones, have given much attention to crane facilities with excellent results. Until the last few years, however, the ordinary hand truck has been used universally for transporting material over the floor. This is not only awkward but requires a large amount of labor. The introduction of the electrically operated truck has proved a wonderful convenience in those shops which have adopted it. With the increasing scarcity of laborers and skilled mechanics the use of these trucks will undoubtedly receive additional impetus.

Boiler Shop Methods

The introduction of autogenous and electric welding has been the most important development in the boiler shop. The improved handling of tubes is also extremely important and is referred to elsewhere. The effect of the federal boiler inspection law has resulted in many cases in improved facilities for repairs and inspection in both the boiler shop and engine terminals. Because of the failure of brazed joints on injector steam pipes the federal locomotive boiler inspection department has recommended the use of a mechanical joint and this has resulted in the development of a special machine for making such joints, known as the banding and beading machine for injector pipe couplings.

Forging Machines

The forging machine has made possible really remarkable economies in smithshop operation. The combined ingenuity of the foremen and their assistants in devising dies and formers has made it possible to many times increase the output of the smithshop with the same number of men, thus proving an important factor in helping to offset the steadily increasing labor costs. Too much credit cannot be given to the ingenuity and resourcefulness of the smithshop forces in developing dies and formers for peculiar and most difficult types of work, which a few years ago were performed by slower, cumbersome and more expensive processes.

Conservation of High Speed Steel

The scarcity of high speed steel and the advance in prices has made it necessary to conserve its use to the greatest possible extent. Solid high speed steel tools have been practically done away with and special tool holders have been designed to utilize small pieces. This has even been carried to the extent of providing special holders to utilize broken twist drills for lathe cutting tools. (*Railway Mechanical Engineer,* January, 1916, page 44.) Even these methods, however, result in a certain wastage and methods have been devised for welding high speed steel tips on soft steel shanks. To reduce the cost of making these welds and overcome failures under heavy cuts because of the uncertainty of hand welding, some roads have arranged for making these welds on forging machines. (*Railway Mechanical Engineer,* February, 1916, page 88.)

Boiler Tube Machinery

In the *American Engineer* of July, 1912, an article was contributed by the late L. R. Pomeroy describing the layout and tools for an ideal boiler tube department. This equipment was designed to handle 450 tubes a day at a labor cost not to exceed three cents a tube from engine to engine. The files of this publication since that time show that Mr. Pomeroy's plan was no idle dream and it was with not a little satisfaction that he saw its success actually demonstrated. Possibly no one department—if we except the reclamation of materials—has had such a general toning up in the last few years as the boiler tube department. The handling of superheater flues has also made it necessary to install tools and appliances for handling the larger diameter tubes.

IMPROVE RAILROAD EFFICIENCY

Increase the Mileage of Locomotives and Cars. Make Repairs to the Equipment Promptly and Thoroughly

THE executive committee of the American Railway Association Special Committee on National Defense has issued the following circular to the railroads of the country outlining ways to increase the efficiency of the railroads:

The European war is responsible for conditions that have caused very large increases in traffic on American railroads, whose capacities are now overtaxed, and they are unable to respond promptly to all demands made on them. In other words, there is a demand for transportation that is not being supplied, and it becomes the duty of your committee to suggest how the present high efficiency of American railroads might be still further raised so as to increase the supply of transportation units with existing plant, forces of skilled and unskilled labor, and supplies of fuel and equipment which cannot be increased because the demand for all of these far exceeds the supply.

Your committee prefaces its suggestions by saying that to many roads they may be unnecessary, but they are offered to all in the hope that they may find them helpful.

It is also recognized that some of these suggestions will increase operating costs, but their purpose being to increase the capacity of the plant the result is deemed to justify sacrifice in a national emergency.

MOTIVE POWER SHOULD BE CONSERVED

1. About 15 per cent of locomotives are ordinarily under repair; if this percentage were reduced to 10, which figure has been reached by some roads, it would mean an addition of 3,325 locomotives to the number in service.

2. The average miles run per day by a locomotive is 75. If by quick turning at terminals, double crewing or pooling, improving the quality of water which may enable a locomotive to double a division without loss of fuel and time involved in cooling down, and with less boiler repairs, this mileage can be increased to 90, which is now reached on some roads, it is equivalent to adding 13,300 to the locomotive equipment.

3. Close attention to boiler repairs enables the locomotive to carry full steam pressure, develop full power at all times, and avoid reductions of pressure demanded by weakened boilers with consequent loss of tractive power.

4. Constant and close inspection of firing methods which will reduce the escape of combustion units in heavy black smoke, also waste of steam blowing off when locomotives are standing, will save fuel and conserve much of it for useful work. During each second a locomotive is "popping" a quarter of a pound of coal is wasted, i. e., a lump of about two inches cube. Careless or ignorant use of steam by the locomotive runner may easily waste a ton of coal on a 100-mile run.

5. Locomotive tractive power falls very rapidly as speed is increased; 20 per cent to 30 per cent more freight can be hauled by limiting the speed and utilizing the full tractive power of the locomotive at 12 or 15 miles per hour. A locomotive is a traveling power plant, 20 per cent to 30 per cent of whose power output frequently is wasted by non-use after generation, either through ignorance or carelessness, in not giving the locomotive its full rated load or in unnecessarily high speed.

6. Excite a spirit of emulation by reporting and circulating the money value of waste of power generated in locomotives and not used.

7. Defer scrapping light locomotives which might be used in branch or light main line service. This will conserve motive power for moving freight.

INCREASED CAR EFFICIENCY

The efficiency of cars can be increased by:

(*a*) Quicker terminal handling and prompter loading and unloading.

(*b*) Better loading—more tons per car.

1. From statistics lately collected, the average time consumed by shipper and consignee averages a little under two days each,—a total of about four days per trip of a freight car for both loading and unloading. This was under the

old demurrage rules, and those now in effect should reduce this time to about 3½ days. Under the old one dollar straight demurrage rule the average detention, including free time of a freight car when in the hands of a shipper or consignee, was 1.73 days. In California, under the $3 demurrage rate, it is about 0.97 days, or about one-half.

2. There are 2,350,000 railroad owned freight cars in the United States and about 225,000 privately owned freight cars, a total of 2,575,000, of which about 6.5 per cent, or 167,000, are normally under repair; close watching and prompt repair work can reduce this percentage to 4, which would release 64,000 cars for active service.

3. The average miles run per freight car per day is 25. Increasing this to about 30 miles, or 20 per cent, is equivalent to adding 515,000 freight cars, or 20 per cent, to existing equipment.

4. Reduce idle time in city and freight division terminals by prompt despatch of trains.

5. Load and unload both company freight and commercial freight promptly—the first, by close inspection and by disciplining offenders; the second by personal appeal by local agents, division and assistant superintendents, and district traffic officers, to shippers and consignees, all of whom can aid greatly by explaining difficulties and obtaining the co-operation of railway patrons in overcoming them through an appeal to their friendship and patriotism. The expenditure of much time, patience, and even money, to make the reform easy in the beginning, is fully warranted. Some one or two consignees can always be found who will co-operate, and once the possibility of accomplishing the desired end is demonstrated, others will quickly follow. There are probably from 250,000 to 300,000 points in the United States where freight is received and delivered. A slight improvement at each will make an astounding aggregate.

6. Increase car loads, which have not kept pace with increase of car capacity, notably in the case of box cars, as shown below:

Average capacity of all cars	39.7 tons
Average load per car, all cars, revenue freight	15.5 tons
Average load per car, all cars (including company freight)	17.0 tons
Per cent of capacity utilized	43 per cent

7. Enlist the interest and co-operation of shippers in loading cars heavier as a war measure, using the services of local agents, superintendents and assistant superintendents, traffic officers, etc., to approach them, concentrating effort on a few friendly ones at first to lead the movement and set the example. Urge shippers and consignees not to ship beyond their ability to promptly handle. Point out the importance to shippers of extending private sidings to correspond with their increased traffic and in improving their facilities to avoid car delay, and, where possible, to arrange their shipments so as to be made uniformly and at periods of the year when cars are least needed to move crops. Require reports of local agents of percentage of cubic and weight capacity of cars loaded at their stations, both as to carload and less than carload freight, also reports of waste in use of cars received by them light-loaded. Publish the results of loading monthly, to excite a spirit of emulation, which will soon affect every agent on the line. Freely interchange with connections reports of light-loaded cars, to correct inefficient loading.

8. Load all cars to 10 per cent in excess of their marked weight capacity. An increase of two tons per loaded car would be equivalent to adding over 200,000 cars to the number available for public use.

9. Where many sheep or hogs are handled, use double-decked cars.

10. Urge traffic officers to make strenuous and concerted effort to get the consent of the public to increase carload minima, thereby increasing the weight of commercial units.

11. Where commercial units are half or less than half the capacity of the car and two shipments are destined to the same point, persuade the shipper to load the two shipments in the ends of the same car.

12. Consolidate under-loaded merchandise cars at designated transfer points.

13. Reduce in every legitimate way empty car haul.

14. The increased number of freight cars available for service without any outlay of capital through (a) quicker repairs 64,000, (b) quicker movement 515,000, (c) heavier average loading 200,000, totals 779,000.

IMPORTANCE OF TRAIN-LOADING

1. Move company freight and supplies so far as possible on trains that cannot otherwise carry full tonnage. Operate work and construction trains as far as possible in slack times. Store company fuel in slack times.

2. Substitute where possible mixed train service for separate passenger and freight train service on branch lines. Closely review the number of scheduled freight trains operated where tonnage is insufficient to fully load them, with a view of reducing the number to trains actually needed.

3. Make the question of train loading one of primary importance, with division officers, train and yard crews through closely checking, at least weekly, records of train performance, giving publicity to them.

IN GENERAL

1. One of the greatest opportunities to increase car efficiency lies in better control of an unusual traffic movement through placing embargoes promptly so as to avoid congestion and delay. The importance of keeping yards and terminals, especially in large cities and at seaports, clear of accumulations which cannot be handled expeditiously, cannot be over-estimated. The experience of the past year has shown that the number of cars held in such accumulations, together with those unduly detained by shippers, have been the chief causes of car shortage. The importance of this question demands the closest possible attention on the part of transportation officers, so that freight which cannot be moved will not be loaded in cars.

2. The executive committee has announced a policy as to car service and has entrusted to the Commission on Car Service the duty of making that policy effective. Unless all carriers co-operate loyally and completely little will be accomplished and the railroads of the United States will be foredoomed to failure in a national crisis. We must recognize that although our railroads have carried a record-breaking traffic since the commencement of the war in Europe, there have been many delays and shortage of service for which they have not been altogether responsible, but which nevertheless have sorely taxed the forbearance of the public. Following these vexing conditions our country has entered the war, which increases and intensifies them.

The committee realizes that it is difficult to obtain the maximum effect of these suggestions because of the great demand for men in all industry and for government service. It is, however, believed that the American railway man is as patriotic as any other, and will help in this national crisis.

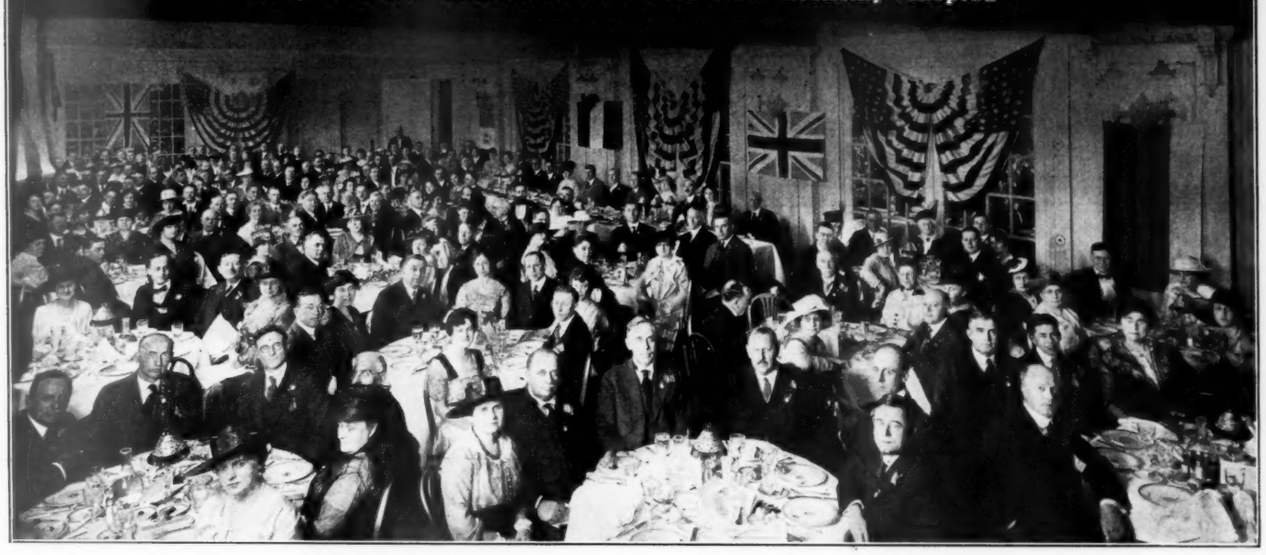
You are urged to have meetings at division points with officers and employees where the seriousness of the national situation can be explained verbally and the greatest interest aroused in this subject of increasing the ability of the American railroads to furnish a larger quantity of transportation with the present plant. This is a result to which it is the patriotic duty of every man in railroad service to contribute his maximum effort.

You are also urged to use the forces of the freight and passenger departments in having meetings with commercial bodies and with shippers so as to enlist their aid.

3. *To our railroads and their officers is presented the opportunity of showing what they can do for their country, and your committee appeals to you to make extraordinary efforts to demonstrate what can be accomplished by the* 262,000 *miles of our railroads in co-operative and unified service.*

FUEL ASSOCIATION CONVENTION

Report of the Ninth Annual Convention Held in Chicago May 14 to 17. Recommendations for Fuel Economy Adopted



THE ninth annual convention of the International Railway Fuel Association was held at the Hotel Sherman, Chicago, May 14 to 17, with W. H. Averill, general manager, New York Properties, Baltimore & Ohio, presiding. The meeting was opened with a prayer by Rev. Reginald I. Raymond. In his address Mr. Averill spoke of the importance of the work of the association at this time and urged that definite action be taken so that as a result of the convention economies in the use of fuel might be put into practice at once wherever possible.

Arthur Hale, vice-president, Consolidation Coal Company gave an address on how the coal shortage has been influenced by the car shortage, stating that for the benefit of both the railroads and the public the mines should be furnished with an ample supply of coal cars.

MR. MODERWELL'S ADDRESS.

C. M. Moderwell, of the sub-committee on coal production of the Advisory Committee of the Council of National Defense, addressed the convention on the coal situation and the war, saying in part:

This war is an industrial game, and nobody is doing any more towards the conducting of this war than you men who stay in your places and see that transportation is furnished. If there is anything we need in this country right now it is coal and transportation.

New England's coal supply, which amounts to about 20,000,000 tons, has been borne by water very largely. It comes from Newport News, Norfolk and Baltimore either by steamer or it is transported in barges hauled by seagoing tugs. The necessities of the government may be such that the government will take the tugs and steamers. The coal to New England will then have to go through Poughkeepsie, Albany and Troy from the Central Pennsylvania coal fields. These points are very congested—are absolutely blocked from one end to another.

Another serious situation is the far Northwest, including some parts of Western Canada. The railroads and the industries and the consumers in that country are in serious and dire distress, or, if not now, they will be when winter comes on. The coal for that country is supplied by Pennsylvania, West Virginia and Kentucky, taken by rail to Lake Erie ports, thence by water to Lake Superior and thence by rail to destination. But this year that production is not going to be adequate. If we get 65 per cent of the coal on the docks when navigation closes this fall, we will be doing extremely well. That means that 8,000,000 or 10,000,000 tons of the coal that is necessary for the railroads and for the industries in that country must come from other fields, largely from Illinois and Indiana, where the transportation facilities and the coal mining properties are already overburdened and can hardly take care of the burden they are carrying now.

Secretary Lane told the committee in plain language that before winter comes America must assume the burden that England has carried of furnishing coal to Italy and France. Now, somewhere and somehow you have got to get the coal. It is a problem of production and transportation. Just how those two items can be brought to co-operate is something that I cannot say at the present time.

This war is a challenge to all of us. We have had 150 years of peace and independence, and if we cannot out of that 150 years prove to the world that we are what we claim to be, and we have had the reputation of being, the greatest organizers in the world, then there is not very much hope for our country.

SUGGESTIONS FOR FUEL ECONOMY

During the convention the association drew up a set of suggestions which, if carefully followed, will have a direct and immediate effect on fuel economy. These suggestions are given in full below:

TO ALL RAILROAD OPERATING OFFICERS

The following suggestions are given for the purpose of calling attention to certain things that can be done immediately to prevent waste of fuel on railroads:

1. Run engines over two divisions wherever possible, in order to avoid waste of coal at ash pits and firing up. See that ash pit delays before fires are cleaned are reduced to

the minimum, reorganizing ash pit forces to provide continuous fire-cleaning service.

2. Work out despatching schedules for all freight trains and have engines ordered for schedule time. If trains or engines cannot be made ready, adjust the schedule to save engines standing around under steam, wasting coal.

3. Increase the supervision and direction of the engine crews, and particularly that of new firemen.

4. Give fuel the same supervision that is usually given to the lubricating oil performance. Four or five scoops of coal are of value equal to one pint of valve oil.

5. Adopt a standard size of scoop shovel, preferably one of small size, which has been found the most economical for all ordinary conditions.

6. See that the use of fuel at power plants is given proper supervision.

7. Detail men to check car loading at mines and at scale stations.

8. Impress upon train despatchers and train crews the necessity for eliminating delays on sidetracks and at meeting points, as far as possible.

9. See that fuel statistics are comprehensive and that they are properly analyzed by division operating and mechanical department officers, so that improper conditions may be promptly corrected.

10. Insist on all transportation officers paying particular attention to the use of fuel. Impress them with the importance of the subject, and that it is more necessary to follow up fuel matters than overtime or other details of operation, from a dollar-and-cents standpoint, as well as from the standpoint of the present fuel shortage.

11. Division superintendents should hold staff meetings to consider the subject of fuel, and in addition instruct their staff officers to hold frequent meetings with enginemen, trainmen and others, gathering them together a few at a time in special meetings in order to emphasize to them the necessity of eliminating waste in the handling and use of fuel. When the group meets, mechanical department officers can review the instructions as to proper handling of engines, firing and boiler feeding.

12. Endeavor to secure the co-operation of engine crews in the economical use of any class of coal the railroads may be forced to use, due to excessive demand for high-class coal that may be required for special industrial and governmental purposes.

13. Have trainmasters, road foremen of engines, fuel supervisors, and traveling firemen follow the work of engineers and firemen as closely as possible, insisting upon engine crews practicing economy and carrying out instructions.

14. Issue instructions to engine crews to take a full tank of coal at all mine coaling stations.

15. Have coal chutes inspected to see that coal chute aprons are so arranged that coal will not be spilled on the ground and wasted.

16. Old ties, old car material, shavings, or any other available material should be used to fire up locomotives, thereby saving coal and conserving forest products.

17. Wherever practicable, store coal so as to help balance the tonnage and to reduce empty-car mileage. In storing coal, select coal of a quality that will not deteriorate rapidly, and locate storage piles where coal may be delivered to engines direct, saving a secondary handling and extra depreciation, if possible.

18. See that coal when stored is so handled as to not be broken up unnecessarily during the process of unloading.

19. Place storage coal on level ground so that it can be picked up free of non-combustible material.

20. Endeavor to have shipper put up coal trestles so that cars may be released quickly.

21. Canvass all industrial coal trestles to see if any can be secured for storage of railroad fuel at points where storage space is required.

22. When purchasing fuel for stoker fired locomotives obtain the largest size screenings the stoker can handle.

23. One large railroad has obtained excellent results by allotting for all engines the amount of coal to be used between time of firing up and leaving terminal. For yard engines similar allotments have been made for the entire period of service. It is suggested that this plan be given a trial.

TO ALL ENGINE HOUSE OFFICERS

1. Have coal shoveled ahead on tenders at terminals remote from the mines, and put no more coal on the tanks at such points than is necessary to take the train back to the terminal nearest the mines.

2. Insist that tenders be not overloaded with coal, avoiding waste on right of way and labor at coaling stations incident to picking it up.

3. Have tools and supplies placed on locomotives before the crew reports, in order to avoid delay at leaving time.

4. Maintain fire door openers, so that they will operate properly.

5. Where fire doors are not equipped with automatic openers, see that provision is made so that the door can be swung open easily and will stay latched open when firing is done in rounding curves, and so that the door can be swung shut easily after each scoop of coal.

6. Maintain brick arches properly in all locomotives.

7. Remove injectors that are oversize and replace them with those of proper size.

8. See that all coal burning locomotives have an air opening in ash pans equal to not less than 14 per cent of the grate area.

9. When locomotive fires are cleaned, see that a competent man inspects the firebox by entering it, insuring that grates are fully cleaned, without broken fingers, and when grate lever keepers are in place and locked that grates are level; see that arches are clean, in good repair, and of standard length. See also that flues are clean and free from leaks, giving particular attention to superheater flues.

10. Do not permit locomotives to be held under steam unnecessarily. When necessary to hold engines bank fires. If held for 24 hours remove fires.

11. When engines under steam are not to be fired up within twelve hours, see that the stacks are covered to hold the temperature.

12. Do not permit fresh fuel to be placed in the firebox of locomotives unnecessarily before fires are knocked out.

13. Do not permit locomotives to leave the terminal with a fire not in proper condition.

14. Maintain boilers to their highest efficiency; wash them when necessary and have the flues of locomotives bored and blown out every trip. Give special attention to the superheater flues.

15. Do not allow locomotives to run with mud ring or front end air leaks. This leakage represents a considerable waste of fuel.

16. Make a special inspection of all locomotives to see that the exhaust nozzles are opened up to the largest area consistent with the proper steaming of the locomotive.

17. Make certain that steam pipes and superheaters are tested at frequent intervals.

18. See that cylinder and valve rings are examined at least once each month, and keep the valves squared up on all locomotives.

19. On oil-burning locomotives maintain all piping, valves and operating fittings in good condition. Keep the burner clean and in proper alinement, making periodical inspections of burners to determine if defective. Pans must

be maintained in good condition and rigidly secured to avoid air leaks at sides and front behind brick work. Inspection should be made each trip to insure brick work being in good condition and all carbon and sand removed. Keep air openings free from slag and carbon accumulations.

20. The flues in an oil burning boiler require the same attention as a coal burner. Dampers should be maintained over all air openings, and must be easily operated.

TO ALL LOCOMOTIVE ENGINEERS AND FIREMEN

To Locomotive Engineers:

1. If your fireman does not employ the best practice, instruct him yourself and ask the road foreman or locomotive supervisor to have a friendly talk with him, setting him right.

2. Advise the fireman as to grades, shut-off points, the length of time it is probable the train will be held in sidetracks, etc., and explain to him your manner of handling the injector, so that he can fire accordingly.

3. Endeavor to work your engine at the shortest practical cut-off all at all times, so as to obtain the full expansive force of the steam used.

4. Endeavor to feed the boiler uniformly, and do not allow the water level to rise so high that the effectiveness of the engine or the superheater will be destroyed.

5. Avoid waste of steam at pops. Injectors will take water as warm as your hand (100 degrees), and heating feed water to this temperature will save about four per cent and increase the steaming capacity of the locomotive on hard pulls.

To Locomotive Firemen:

1. Break all large lumps of coal, so that no coal will be wasted by firing such large lumps.
2. Keep the deck clean.
3. Do not permit coal to fall off the gangway.
4. Close the fire door after each scoopful of coal is fired.
5. Do not slug the fire.
6. Three or four scoops to a fire, even with the largest engines, give the most economical results.
7. Do not shake the grates except when absolutely necessary, and then only slightly.

W. H. Averill (B. & O.)
President

E. W. Pratt (C. & N. W.)
Vice-President

L. R. Pyle (M., St. P. & S. S. M.)
Vice-President

W. L. Robinson (B. & O.)
Vice-President

J. G. Crawford (C., B. & Q.)
Secretary-Treasurer

OFFICERS OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION

8. Do not rake the fire except to fill a hole or break up a bank. When engine is drifting, fire only sufficient amount to maintain fire in proper condition.

9. Study the problem of proper firing. Talk about it with other firemen.

10. Get all the pointers you can from your engineer, and practice the principles of proper firing as your share in helping to solve the fuel problem.

11. On oil-burning engines, sand flues often and save fuel by preventing black smoke, the same as on coal burners.

PROBLEMS WELL WORTH CONSIDERATION

It was the sentiment of the convention that investigations conducted with a view to securing greater economy in the use of fuel should be carried on energtically at this time

and the following suggestions were made with regard to such work:

The use of some portion of the vast deposits of lignite coal underlying the western territory for locomotive fuel purposes deserves special consideration, and an attempt should be made at an early date to investigate through the medium of adequate tests, preferably made in a locomotive testing plant, the possibility of extending the use of this grade of fuel in pulverized form or otherwise. The practical solution of this problem would assist in solving the fuel question on several roads serving a vast territory located remote from an existing acceptable fuel supply, reducing materially what now represents, because of the long haul, a heavy transportation effort.

The feed water heating devices now receiving serious attention from railway mechanical officers represent economical possibilities deserving of serious consideration, and tests on an adequate locomotive testing plant should be arranged to assist in the development of this fuel saving principle.

This association will continue to urge on American railroads the necessity of concerted effort toward securing, by properly conducted tests on a specially constructed test locomotive employed in a testing plant, that refinement in fuel economy which the magnitude of the problem so fully warrants, and it is recommended that an adequate appropriation for this purpose be made by the railroads, all of which would benefit by the results attained.

The co-operation of the Bureau of Mines should be requested in the matter of making a thorough scientific study of locomotive furnace conditions, the solution of the problem of slag or honeycomb formation alone warranting any effort made in this direction.

CONCLUSION

The above recommendations, if carried out in a thorough and conscientious manner, will result in effecting such saving and conservation of the fuel supply as will reflect to the credit of each individual contributing thereto, and will represent in the fullest sense an adequate and patriotic answer to the call of the President and the Council of National Defense.

THEORY, PRACTICE AND RESULTS OF FUEL ECONOMY

BY W. P. HAWKINS
Fuel Agent, Missouri Pacific

One of the largest single items of waste of fuel can occur at terminals by allowing engines to remain under fire longer than necessary, first, by too long a delay between the time they are detached from their train after arrival and the time the fires are knocked, and, second, by firing them up earlier than necessary before departure.

Any and all delays encountered in housing engines after arrival, in addition to wasting coal, reduce the time that should be used for washing out boilers and making necessary repairs, and in many instances the direct cause of engine failures can be traced to the fact that the engine, while at the terminal possibly seven or eight hours, was actually in the roundhouse but three hours. The work that must necessarily be neglected on engines by not housing them promptly, and the hours of service of the locomotives which are lost to the transportation department from such delays, should make the amount of coal lost a secondary consideration.

Despatchers or yardmasters, whose duty it is to order engines, should be in a position to furnish the roundhouse foreman correct figures as to the time the engines are needed, and allow sufficient time to fire them up so that they can be taken out of the roundhouse in ample time to make any necessary preparation for their departure on the time of the call. This time might vary from two to three hours, according to the facilities for handling engines and the distance and convenience of the tracks between the roundhouse and the train yard.

Firing up engines in anticipation of call is a very bad practice for many reasons, and should be permitted only in exceptional cases, where it is considered expedient to protect against delays to traffic on main line divisions. In such cases it should not be necessary to hold more than one engine under fire for protection, and this should be the engine which is due to leave the terminal first.

Where an engine is allowed to stand for a long time under fire the front end netting may become stopped up and the fire becomes dirty, which often results in the engine not steaming well on the road. Records show that many engine failures are charged to engines being allowed to leave the terminal with the fire in bad condition, with resultant loss of coal during the trip, and where it is a practice to fire up engines in advance of call, additional labor is necessary to watch the engines in order to keep the fires alive and to take care of the water in the boilers.

We know of one large terminal where such delays occurred frequently, and where the average time engines were held under steam unnecessarily was very high. The matter was handled directly with the division superintendent and roundhouse foreman, who claimed that no engine was fired up unnecessarily, and did not give much hope that any improvement could be made. The matter was not allowed to drop, however, but was checked closely for several days by a man who was familiar with all of the customs and practices in connection with the handling of engines at terminals, with the result that at the expiration of two weeks this same roundhouse foreman made a report voluntarily that he was making a saving of approximately twenty tons of coal per day by carrying out the suggestions of the fuel department.

Suppose that on any large railroad there are 20,000 engines handled at the various terminals during one month, and that each engine is held under steam an average of six hours. If it were possible to reduce this time by closer supervision to four hours per engine, there would result a monthly saving of 1,500 tons of coal, these figures being based on an average hourly consumption of 75 lb. per engine, which is considered low.

Another large waste occurs if proper attention is not given to firing up engines. If 75 shovels of coal are sufficient to raise 100 lb. of steam in order to handle the engine out of the roundhouse, 100 or more shovels should not be used. The probability is that the additional number of scoops of coal used may only result in the engine popping off several times before it is attached to the train, causing both waste and annoyance.

Every engine should have as large a nozzle as it is possible to use, and enable the engine to make steam freely. If engine is failing for steam the nozzle should not be reduced until full investigation has been made, in order to determine whether or not the engine has any other defects which might in any way contribute to the failure. A record should be kept showing the size of the nozzle in every engine, and every change made in the nozzle or front end should be reported for record. It is necessary that all joints around the front end be kept absolutely air tight, and that the area of opening in the front end netting be as large as possible. The air opening in ash pan should not be less than 14 per cent of the grate area and 100 per cent of the tube area. Insufficient air opening will likely make it necessary to operate the engine with a reduced nozzle opening. A reduction of from one-eighth to one-quarter inch in the size of the nozzle might easily cause a waste of from 2,000 to 4,000 lbs. of coal per trip over the average division.

Leaky steam pipes or nozzle-stand joints will cause a waste of 2,000 to 4,000 lb. of coal per trip. In many

instances locomotives are allowed to run until they make several failures before steam pipes are tested, and frequently are continued in service after they are found leaking by some make-shift arrangement such as bridging the nozzle or putting cement around the joints, which, at the best, is only a temporary arrangement. If this results in keeping down complaints from the engine crew there is likely to be no more attention paid to the engine until it fails again, and in the meantime it is consuming coal almost beyond the capacity of the tender. Steam pipes should be tested every time an engine is held in for repairs as long as two days or more.

Valves or cylinder packing blowing might easily cause a waste of one or two tons of coal over a 125-mile division. In addition to the waste of fuel, an engine cannot perform its service satisfactorily or haul its full tonnage rating with defects of this nature. It is considered good practice to examine cylinder packing every 30 days, as experience has demonstrated that it is not always possible for an engineer to detect a blow in the cylinders of a large engine. We know of instances which have occurred recently where this defect was not discovered until after the engines were reported failing for steam and not handling their trains successfully. After making the usual changes in the front end, and testing steam pipes without any improvement being made, the cylinder packing was examined as a last resort, and was found worn out and broken. The saving of coal and increased efficiency to be procured by examining the cylinder packing at regular intervals will, no doubt, more than offset many times the expense of examination.

Valves out of square, making it necessary for an engineer to work the engine in a longer cut-off in order to get over the road, is another serious defect which causes an excessive amount of fuel to be consumed. Tests have shown that it is possible for an engine to consume as much as 25 per cent in excess of the required amount of coal on account of the valves being out of square.

Defective, broken or burnt grates will cause a loss of from 100 to 200 lb. of coal every time an engine is fired up in the roundhouse with mine-run coal, and will cause a continual waste on the road. They also allow holes to get in the fire, probably resulting in steam failure before the completion of the trip.

Leaky safety valves do not always seem to be given proper consideration. Where safety valves which are set to pop off at 200 lb. commence to blow at from 150 to 180 lb., there is a constant drain on the boiler, and the loss of fuel from this cause is very great.

Superheater units in all superheated locomotives should be tested regularly at intervals of not more than 60 days, and where the joints are found leaking repairs should be made with the least possible delay. We have record of cases where engines lost 60 tons of coal in one month, compared with engines of the same class hauling the same tonnage over the same division, due to superheater unit joints leaking, and yet the engines performed their service apparently satisfactorily to both the transportation and mechanical officers of the division.

All tubes should be kept thoroughly clean. Investigations have shown many times, where engines are reported failing for steam, that the failure was entirely due to a large number ber of tubes being stopped up. We know instances where the tubes were reported to be bored out by engineers and from all indications, looking into the firebox from the engine deck, the work was apparently properly done. A closer investigation, however, developed that the ends of the tubes were cleaned out for a distance of only 10 in. or 12 in. The improper boring of tubes occurs so frequently in many roundhouses that the importance of close supervision of this work should not be overlooked.

Experience has proved that a locomotive with a tender holding from 14 to 16 tons of coal can easily lose from 500 to 1,000 lb. along the right-of-way for the first 25 or 30 miles out of the terminal, where it is a practice to overload the tenders before leaving. Large openings in the deck and around the grate shaker rigging, or over the draw-bar pin, left uncovered, will cause waste of 100 lb. or more of coal each trip over the road, and where some protection is not provided for preventing coal from falling out of the gangway on both sides another large loss will occur daily.

Fuel supervisors or road foremen of engines can easily keep a check on all defects and on their frequent trips over the road they should never lose sight of the importance of instructing engineers and firemen in the best and most economical methods of handling the engines in their charge. They should follow up the work they report and see that it is done in a reasonable length of time, and if not, take whatever steps may be necessary to assist in having it done.

Where monthly meetings are held by the division officials, the fuel supervisor or road foreman of engines of the division should attend these meetings and discuss thoroughly all matters relative to fuel economy. At such meetings much good might be accomplished by bringing up such matters as poor meeting points, long delays on sidings, and all matters which tend to the prompter movement of trains. It is considered to be a conservative estimate that any large modern locomotive will use anywhere from 500 to 1,000 lb. of coal every hour it is held on a side track.

The constant efforts of division officers should be directed toward keeping the average gross tons per train mile hauled as near to the maximum as possible. If the average gross tons per train mile are allowed to decrease, there will be an increase in the number of pounds of coal consumed per hundred gross ton miles. It has been proved that where a certain class of engine will use nine tons of coal over a 118-mile division with a train of 1,700 tons, the same engine will burn only 15 tons over the same division with a train of 3,400 tons, giving an increase of 100 per cent in tonnage hauled, with an increase of but 66 per cent in the amount of coal consumed.

As all the defects enumerated are ordinary running repairs that should be kept up daily, and can easily be completed at a cost of from $5 to $30, engines should not be permitted to remain in service with such defects until they have lost $75 or more in the additional amount of coal consumed before repairs are made.

There should be some practical method in force for checking coal consumed by each locomotive daily. Such a record should be kept either in the office of the superintendent or master mechanic. This record should be consulted frequently during the month by the master mechanic and fuel supervisor, and where an engine is showing an increased consumption in pounds of coal per hundred gross ton miles, immediate action should be taken to improve on its performance. The accounting feature should receive serious consideration, in order that the amount of coal shown delivered to locomotives on performance sheets may agree approximately with the auditor's figures at the end of each month. A good method is to have each coaling station adjust the difference each day on fuel charges to locomotives, or, in other words, each coal chute should balance every day.

It is obvious that the fuel agent, or whoever is in charge of fuel economy, must have the co-operation of the mechanical and operating officers. Where results and practices indicate that such assistance is not forthcoming, he must be in position to point out the shortcomings of the parties at fault, regardless of the position they may hold on the division, and take whatever steps may be necessary to bring about the improvement and results that are desired.

DISCUSSION

The saving which can be made in the fuel used at terminals is very large. Delays on the road also add a consider-

able amount to the railroad fuel bill. The possibility of saving by better despatching should be brought to the attention of the officers in the transportation department. Coal should be carefully inspected at the mines and chutes must be arranged so that no fuel is lost when loading tenders. The steam pipes should be tested periodically, but the advisability of doing this work whenever the engine was held for two days or more was questioned.

OTHER BUSINESS

Committee reports on Fuel Tests, Powdered Coal, Kindling Fires in Locomotives, Graphic Display of Individual Fuel Records and Locomotive Feed Water Heating were also presented. The report on Locomotive Feed Water Heating is abstracted elsewhere in this issue and abstracts of the other reports will be published in future issues.

A paper on Fuel for Small Furnaces was presented by Joseph Harrington, which dealt with the construction and operation of furnaces using oil and powdered coal. A paper on Soot was also presented which took up the matter of deposits from fuel on the heating surface of boilers and emphasized the advantages of mechanical soot cleaners. The standing committee on Front Ends, Grates and Ashpans made a progress report and a report was presented on the Storage of Coal.

A. I. Lipetz, of the Imperial Russian Railway administration, told of the methods of conducting road tests used in Russia. At the closing session a resolution was adopted to the effect that the association offer its service to the Council of National Defense and to the American Railway Association. The executive committee was empowered to appoint a committee to work with these bodies. The secretary reported a large increase in the number of members, the membership of the association at the time the convention opened being 739. The president suggested that a membership more representative of both the mechanical department and operating department and of all sections of the country was desirable.

The finances of the association were reported in a satisfactory condition.

The following officers were elected for the coming year: President, E. W. Pratt, assistant superintendent motive power, Chicago & North Western; vice-presidents: R. Bradley, inspector fuel service B. & M.; L. R. Pyle, fuel supervisor M., St. P. & S. Ste. M.; W. L. Robinson, supervisor fuel consumption B. & O. Executive committee: For two years, W. C. Arter, supervisor apprentices, N. Y. C.; W. J. Bohan, mechanical engineer, N. P.; W. P. Hawkins, fuel agent, M. P.; J. D. Hurley, general road foreman, Wabash, and H. B. McFarland, engineer tests, A., T. & S. F.; for one year, H. Woods, fuel inspector, C. & S. Of the five cities from which the executive committee will choose the place for the next meeting Chicago received the greatest number of votes.

THE MACHINE TOOL SITUATION

The machine tool situation at the present time is one of great uncertainties, but to railway men, it is a sign of encouragement that the railroads have been more active in the market in the past three or four months than they have been in the past two years. Within the past few weeks a number of railroads have entered the market with inquiries. The number of roads has not been large; it has included the Lehigh Valley, the Santa Fe, the Pennsylvania, the Lackawanna, the New Haven, the New York Central and finally the Illinois Central. Nor have the inquiries been large, although the Illinois Central's list includes no less than 94 tools for shops all over its system.

The market for machine tools is uncertain for a large number of reasons, among them being the as yet unsettled matter of government contracts, the question of priority of shipments, the demands for tools from abroad and finally the questions of prices and delayed deliveries.

The prices of tools, as is well known, are extremely high, so high in fact, that certain interests have even been able to sell second-hand tools used for many months on munitions work at far higher prices than was paid for them. Others have drawn attention to the fact that prices now are based on a cost of production somewhat higher than the selling price two years ago. Machine tool builders, in addition, are not eager to make wild guesses as to what the future will bring forth. For some time builders have been offering tools on the basis of billing at the price at the time of delivery while others are now going so far as to make contracts subject to price revision one month before delivery.

Deliveries on a great many machines are very much delayed, and the matter of delivery is further complicated by the question of priority. At the present time many builders are sold so far ahead that such tools as milling machines, radial drills, planers, boring mills, horizontal boring machines and shapers cannot be obtained this side of 1918. On some tools which are in even greater demand it would be extremely difficult to secure delivery in less than a year or even more. The demand for ship building equipment is rapidly bringing about similar conditions as to punches and shears. In fact, some of the liveliest purchasing at the present time is being done by shipbuilders.

Naturally, the practice is, insofar as possible, to grant precedence in deliveries to firms working on government contracts. Many machine tool manufacturers have been in receipt of instructions from the Washington authorities to rush deliveries to such plants. Luckily for the other purchasers of machine tools most of these plants are, as a rule, already fairly well equipped with necessary tools. That is to say, the orders from these individual firms run fairly small, but on the other hand, it is still true that there are many of these small orders, and that each such order delays deliveries to other purchasers. Some builders have even had to say that they cannot promise deliveries, but that they will tentatively set a date at which they will try to make delivery.

This brings us to the question of priority of deliveries. This is in the hands of the general munitions board at Washington which in general has prescribed that priority shall be given about as follows: To shops working on contracts for the allied governments; to shops working on contracts for the United States government; to shops working on essential commercial work, and finally to shops working on non-essential commercial work. Just where the railroads stand in this scheme of things is not clear. Presumably they are looked upon as shops on essential commercial work, for the authorities generally realize that efficient maintenance of railway rolling stock is one of the prime essentials in the war.

The buying of tools for railway shops, it is clear, is a matter receiving very careful attention at the present time. The roads that are placing orders are those that have an eye to the future and realize that now is the time to buy equipment necessary to hold them over until normal conditions are once more restored. Railway officers have been considerably impressed by the emphasis placed by the leaders in Washington on the fact that the war is going to last for years rather than months. They have read with a great deal of interest the statement of H. C. Hoover, the food administrator, declaring that "we face a conflict that may last two to five years." They are also considering carefully that new cars and locomotives will soon be harder to obtain and that it will be more and more the work of the shops to make up for the lack of new equipment by the best possible maintenance of old equipment. Whether the realization of the necessity for covering requirements for shop tools for possibly two to five years ahead will increase the buying of machine tools by railways under present conditions of prices and delivery is a question.

SHOP PRACTICE

ELECTRIC WELDING ON THE ROCK ISLAND

BY E. WANAMAKER
Electrical Engineer, Chicago, Rock Island & Pacific

The Rock Island has been one of the pioneers in the development of electric welding as applied to railroad work. The first installation was made several years ago and consisted of two single and one double Siemund-Wenzel unit. After several years' experience with these welders it was decided that it would be possible to use electric welding in railroad work on a large scale, if properly designed machines could be obtained. It had been found essential to have

Portable Electric Welding Machine

welding machines that would permit close regulation and control of the welding arc.

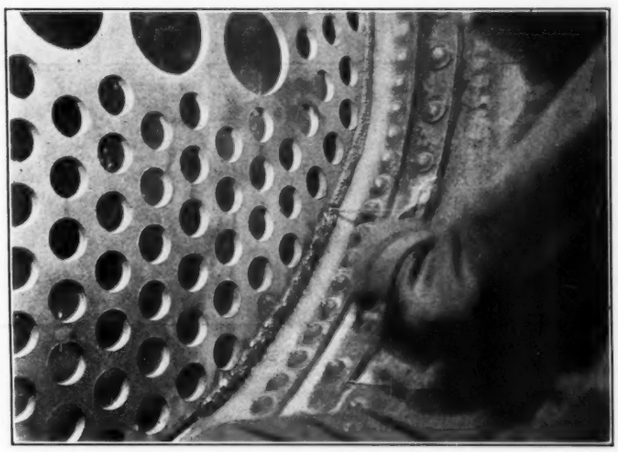
In planning the installation a careful analysis was made of the service which is demanded of electric welding equipment in railroad shops and engine houses, and an attempt was made to design an installation which would show under such conditions, maximum reliability and flexibility, with minimum installation and operating expense. It appears certain that the welding process will find even a wider field of usefulness than is evident at present. This condition led to the conclusion that the present installation should be made in such a manner as to lend itself readily to enlargement should it be required. The lack of standardization of operations in the present practice made it extremely difficult to predict accurately what size installations would be required at the various points on the system, and it appeared desirable to purchase equipment which could readily be moved from one point to another, until the proper distribution could be obtained.

It was considered particularly desirable to have the arc welding equipment available at all points in the shops and engine houses, since it is quite certain that the advantage of the low cost of operation of the electric process is lost if the locomotive must be moved from a haphazard location to some special point where the power for welding is available. These features led to an analysis of distributing systems for the welding current and brought about an investigation of the possibility of using portable arc welding equipment, similar, so far as possible, to the portable gas welding outfits.

With the total capacity divided at each shop among several units, it appeared certain that as long as the power was available there would not be a complete shut-down of the welding equipment. Each operator would be entirely independent of the others, although as many as desired could be concentrated on any engine or job in the shop.

The operating economy of the units, while not a deciding factor, was found to be important, since at some of the shops the power plants were already loaded almost to their capacity, and at other points the cost of the power purchased from small central stations was rather high. Under these conditions the variable voltage equipment was considered the best because this type eliminates the resistance ballast from the arc circuit, thus increasing the power economy of the units to such a degree that a single-operator unit may be operated from a power line large enough to carry a 5 hp. motor.

As a result of the analysis of the requirements of the shops



Welding a Front Tube Sheet

33 individual welding machines were purchased, ten of which were fixed machines to be mounted on brackets located on shop columns, while 23 were portable machines weighing, complete with the truck, approximately 1,700 lb. All of these machines are motor generators, the generators having inherent regulation. The portable machines are equipped with ball bearings which will require lubricating only once every six months. The ten stationary machines have bearings with ring oilers and are permanently located on columns in the main shop. Part of the machines

have 230 volt d. c. motors and part of them 440 volt, three-phase, 60 cycle, a. c. motors, these two power voltages being standard on the Rock Island.

As noted above, the majority of the welders are of the portable type. These have aptly been termed the "flying squadron," as they can be used at any point on the system which is equipped with power circuits. At the majority of these points the power voltage is 440. This makes it possible to reduce greatly the cost of the wiring installation, as it is only necessary to run comparatively small wires through the shops, roundhouses, etc., placing suitable receptacles at as many points as is deemed convenient, in order that the welding machines may be plugged in in a manner similar to the plugging-in of any extension circuit.

At the main shops in Silvis, Ill., there were installed, in addition to one double and one single Siemund-Wenzel welding machines, ten stationary machines. Outlets for eight portable machines were also provided. All the welding machines at this point use d.c. power.

There are seven points which have the necessary wiring completed. There are, however, fourteen additional points, where the welding machines can be connected up in case of emergency, which could be wired permanently so the machines can be used in the same way as at the points where the installation has already been made, at comparatively slight expense. In fact, most all points of any size can have the permanent wiring installed complete for $500 or less. It is very easy to install wiring for the welding machines at the time the lighting or power circuits are being run.

Bottom Locomotive Drawbar Pin Hole Welded

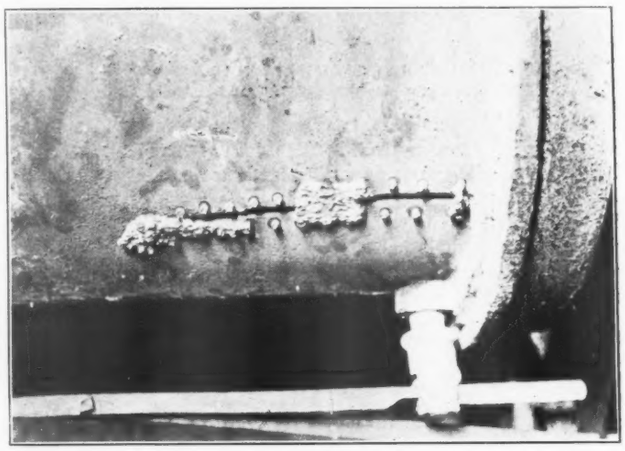
The total cost of installation per operator for the individual machines is given in the following table:

Cost per operator of multiple unit machine with a capacity for four operators, approximately	$1,400
Cost per operator of multiple unit machine with a capacity for eight operators, approximately	1,240
Cost ot individual stationary machine for 250 volts D. C., approximately	900
Cost of individual stationary machine for 440 volts A. C., approximately	980
Cost of individual portable machine for 250 volts D. C., approximately	900
Cost of individual portable machine for 440 volts A. C., approximately	980

With a system including portable machines, such as has been installed on the Rock Island, the installation of electric welding equipment is converted into a system proposition rather than a series of plants to take care of certain shops or terminals. The system is extraordinarily flexible and has many desirable features that would be impossible to obtain with any other system or type of machine. For instance, if it is found that one or more additional machines are needed at any shop it is very probable that some can be transferred from some other point, which has more than can be used to advantage at that time, and it is only necessary to pull one of these machines into a car, block it substantially, and bill it to the point at which it is needed. Immediately upon its receipt it is ready for operation.

OPERATING AND MAINTENANCE OF ELECTRIC WELDING EQUIPMENT

The installation was designed and made by the electrical department. The division electricians at the points where welding installations have been made were given sufficient instruction to enable them properly to operate and maintain the equipment, being supplied with references for ordering any repair parts that would eventually be required. As soon as possible after the installation had been completed, the supervisor of electrical equipment, accompanied by an



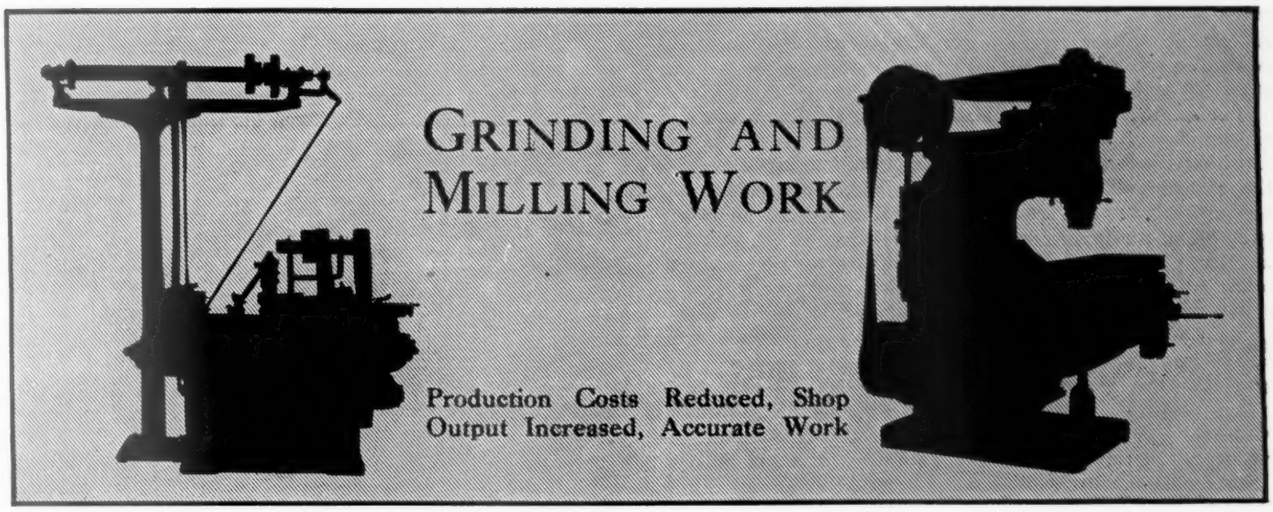
Welding Locomotive Cylinder by Welding Over Studs

expert demonstrator from the manufacturer would visit the point and instruct as many men as deemed necessary in the use of the electric arc. As is evident, these instructions are only preliminary and it is intended to continue giving instruction as frequently as possible in order to realize the full benefit from the equipments.

A complete set of instructions for electric welding has been issued, consisting of about 30 typewritten pages, to which additions will be made from time to time. These are supplied to all who are interested in the development of electric welding. The instructions begin with an explanation of the electric arc itself, continuing with the proper polarity for different classes of work. The next point covered is the amount of heat used, the kinds and sizes of electrodes and the current and voltage for the different classes of work. Immediately following are the instructions for all kinds of firebox welding, including the proper use of protective shields. This in turn is followed with complete instructions on the proper methods to use in welding frames and cylinders, and in all building-up operations.

The proper preparation of the work is fully as important as the welding operation, if not even more so. The instruction book supplies detailed sketches showing the proper method of preparing work for welding, including a detail of a small portable sand blast. Several pages are devoted to the properties of iron and steel, in order that welding may be intelligently accomplished. In conclusion there is a long list of locomotive and car parts, machine tool parts, etc., which it has been found can be successfully and economically welded.

There seems to be practically no limit to the application of electric welding when a good welding machine is intelligently used by a competent operator who thoroughly understands metals as well as the handling of the arc. The illustrations show some of the welders and a few samples of the work which has been done. The results up to the present time indicate that the net returns from the electric welding installation will be far greater than had been anticipated.



AS a means of reducing shop costs and increasing the shop output, the Pennsylvania Railroad has developed to a large degree the use of grinding and milling machines in its Juniata shops at Altoona, Pa. It has been found by several years' experience that both these types of machines have a wide range of usefulness. The milling machines will do a large amount of work cheaper and quicker

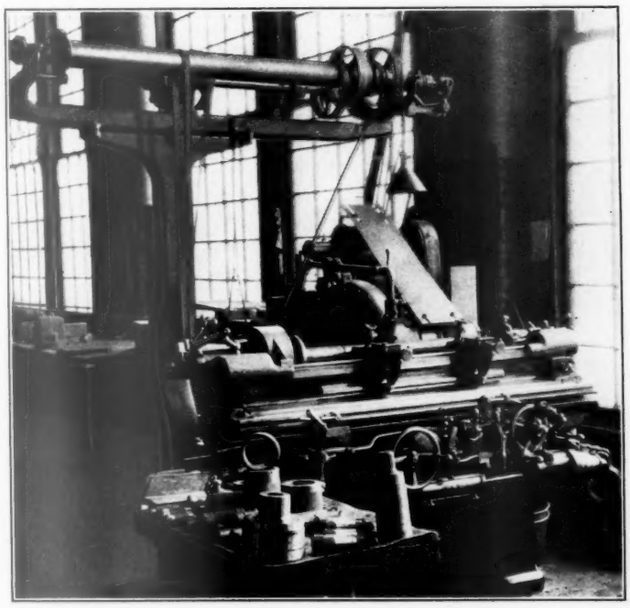


Fig. 1—Grinding Screw Reverse Screws—Other Work Done on This Machine Is Shown on the Table in the Foreground

than it can be done on a planer, shaper or slotter. The grinding machines are used for finishing work that was previously done on lathes and planers. The experience at this shop has shown that in many cases it is cheaper to take a finishing cut on a grinder after the material has been roughed out on a lathe or planer. In numerous cases the saving in the cost of labor effected by the use of grinding machines is as high as 40 per cent. In addition to this the work is more accurately done and the limits of variation from the true dimensions adhered to in this shop are quite remarkable for a railroad shop. The limits set and which are carefully followed in all the work where refinement is desired vary from .002 in. to .005 in.

The grinding equipment on which the work to be described in this article is done consists of a large and small Norton grinding machine, a Pratt & Whitney vertical surface grinder and a Heald internal grinder. The milling machine equipment consists of two 48-in. by 17-ft. and one 30-in. by 6-ft. Niles-Bement-Pond slab milling machines, a Cincinnati, a Brown & Sharpe and a Becker milling machine.

GRINDING PINS AND RODS

The work well illustrating the economies to be effected in grinding is the finishing of all kinds of pins and rods which must have a smooth finished surface and accurate fits. The large and heavy work is done on the large Norton grinder which has a bed long enough to take an extended piston rod for a modern Mikado engine. This machine was designed especially for this work. It has a 14-in. swing and will handle work 10 ft. long and is equipped for grinding tapers. It is used to finish all crank pins, piston and valve rods and other long rods or shafting which require an accurately finished and true surface. Previous to the installation

Fig. 2—Vertical Surface Grinder for Grinding Rods

of this grinding machine, the entire work on main crank pins was done on the lathe. They are now rough turned on the lathe to within 1/32 in. of the required diameter and finished on the grinding machine, the wheel fits being ground to size, at a piece work price for the entire job 34 per cent less than that previously paid. The front and back pins are handled in the same way at a reduction in the piece work

price of 31 per cent. The saving effected in the finishing of extended piston rods by grinding is 40 per cent of the price formerly paid. This includes all work on the rod, the taper fits and all.

The smaller Norton grinder is used for the less heavy and shorter work. The work done on this machine consists of finishing the outside of the side rod knuckle pin bushings, the knuckle pin itself, crosshead pins, driver brake clog hanger studs which are tapered, the outside of the piston valve stem bushing for extended valve rods, superheater damper pistons and shafts, link and valve motion pins, screw reverse screws (see Fig. 1), lathe centers, milling machine arbors, pipe centers for lathes, the outside of bridle link bushings, taper pins for tube expanders, and so forth. Similar savings are made on this machine as on the larger grinder.

The crosshead pins are now rough turned on a lathe to within 1/32 in. of the finished diameter and finished on the grinder at a cost 40 per cent less than when they were finished complete on the lathe. The driver brake clog hanger studs which are tapered, are now done 16 per cent cheaper than before and the prices paid for taper pins for tube expanders are about one-third as much as when these pins were finished on the lathe. All the above comparisons are of piece work prices and indicate directly the increase in shop output. In no case have the men lost money by the institution of these practices and in most cases they have been able to increase their daily net return with less labor.

VALVE GEAR MOTION WORK

The combination of both milling and grinding as practiced in these shops is well illustrated in the work done in making the various parts of the valve gear motion work. Almost this entire job is done on milling, drilling and grinding machines. The only planing done at all is on the flats of the link and link block and on the curved surfaces of the link slot and the link block. The link is planed to 1/32 in. of its required thickness, 1/64 in. on each side being left for grinding, while .01 in. is left on each side of the slot for grinding. The sides of the link are ground on the vertical surface grinder. The work was done previously under vertical grinder with a rim grinding wheel and the saving effected by the surface grinder is 73 per cent in the piece work price.

The surface grinding machine is used for a variety of purposes. In addition to grinding the links, it finishes the top and bottom of the guides, the screw reverse gear guides, main and side rod ends (see Fig. 2), crosshead keys, main rod keys, main rod gib bolts, knuckle joint pin washers, eccentric cranks, reach rod centers, guide bar liners, reverse lever quadrants, etc. It is provided with a magnetic chuck which greatly facilitates doing the work.

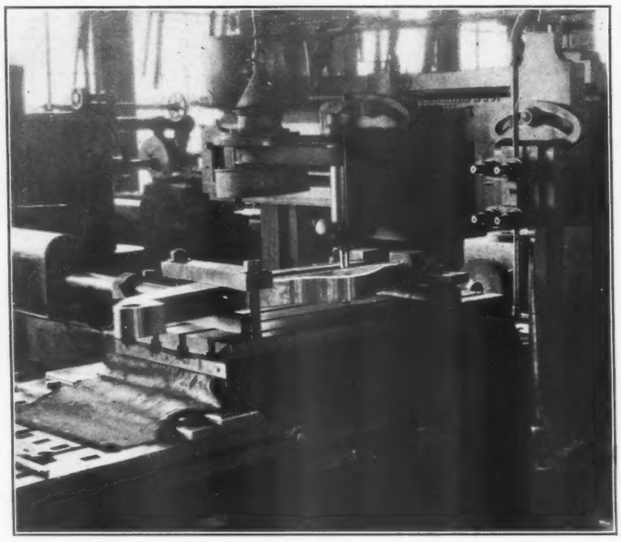


Fig. 4—One Head of Radial Planing and Grinding Machine

The only slotting done on the valve gear motion work is to cut out the slot in the link and to cut an offset for grease cups in the lower ends of the link and radius rod. The slot in the link is cut with a narrow slotter tool, three holes being previously drilled in the link to start the work, one at either end and one in the middle. The edges of the links are milled in pairs in a vertical miller and later buffed on a swing grinder after the links have been casehardened. The slots in the links are roughed out on the radial planing and grinding machine shown in Fig. 3. The links are set for this operation in the illustration and by careful examination of the illustration, the planing tool will be observed just back of the grinding head and directly above the slot in the link.

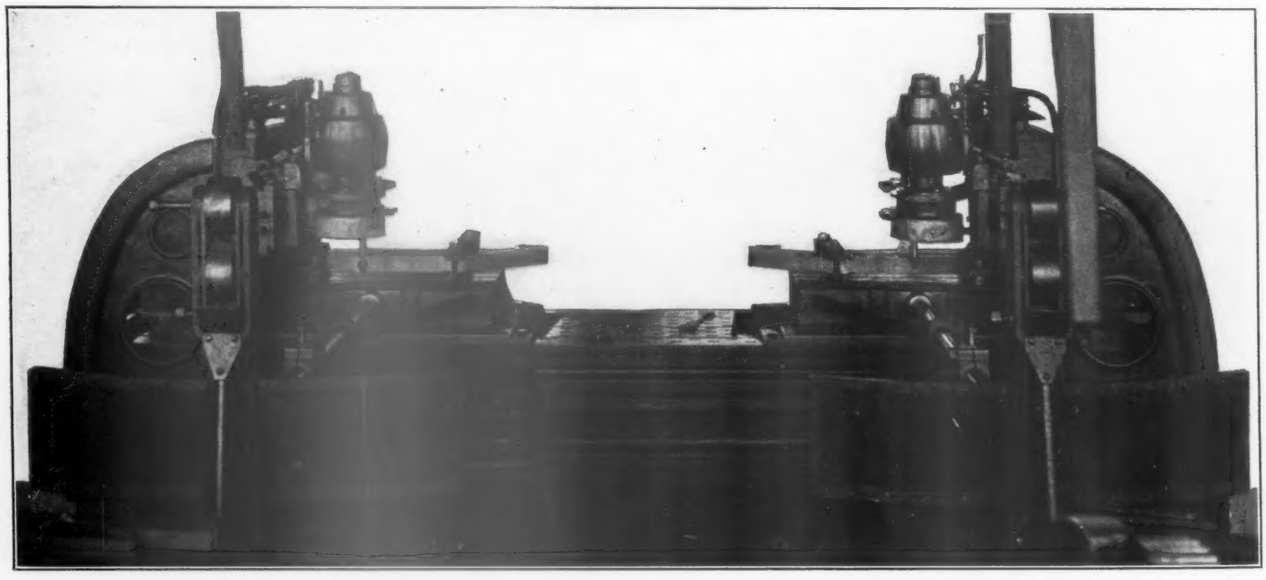


Fig. 3—Radial Planing and Grinding Machine for Valve Motion Links and Link Blocks

Fig. 4 shows the grinding head in operation and more clearly shows the radius attachment of the machine.

The link blocks are made from wrought iron forged bars made of selected scrap. These bars are rolled cold to the approximate radius and are rough planed on the faces on a

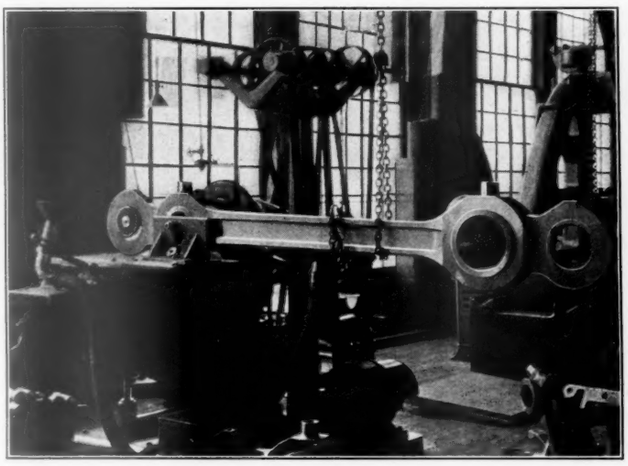


Fig. 5—Grinding Knuckle Pin Bushings in Side Rods

table planer, the edges being planed on the radial planer in Fig. 3, 1/32 in. being allowed for finish. They are then cut to length and drilled for the block pin and oil cavity. They are then casehardened. The sides are ground to dimension on the vertical surface grinder and the curved faces are ground on the radial grinder. The hole for the pin is ground in the Heald internal grinder. All grinding work is held to an accuracy of .002 in.

The various rods and links in connection with the valve

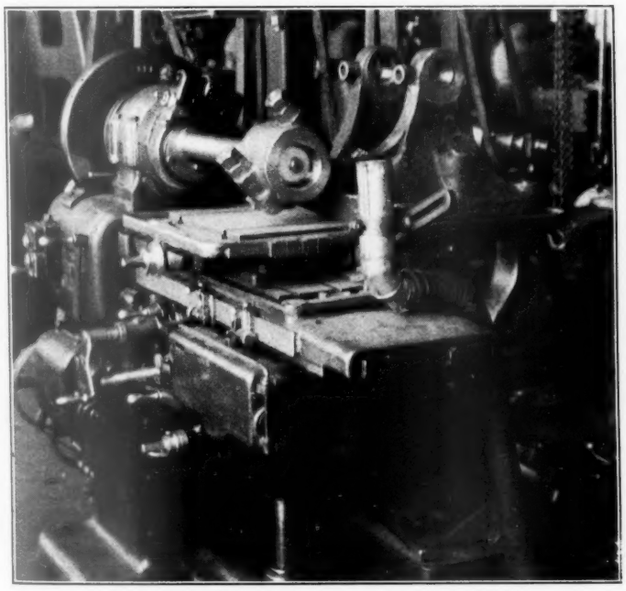


Fig. 6—Grinding Bushings in the Link and Lift Shaft Bracket

motion work are finished entirely on the milling machines. The eccentric rods, radius rods and lap and lead levers are all milled on a slab miller, as many being milled at a time as the table of the machine will accommodate. The radius rod links and the lap and lead rod links are milled on the edges and flats on a smaller machine. The ends of all the rods are milled on a vertical miller and the jaws in the eccentric rod, radius rod and the links are milled in the same machine. The long jaw in the radius rod is also milled, the work previously being done on a slotter.

The valve gear motion work is provided with casehardened bushings at every pin. These are ground to size after hardening, on the Heald grinder, .002 in. being the allowable variation from the exact dimension. This machine has proved very valuable for this class of work. It has a wide range of usefulness and at these shops it is used for grinding out the interior of knuckle pin bushing after being applied to the side rods (see Fig. 5), the pin hole in the link

Fig. 7—Slab Miller for Machining Rods

guide block, the hole in the link and lift shaft bracket (see Fig. 6) and all other interior grinding that is necessary.

MAIN AND SIDE RODS

Both the slab and vertical milling machines are used to a large extent on the main and side rods. Fig. 7 shows a group of side rods on one of the slab milling machines, the edges having just been milled. Eight rods are milled at a

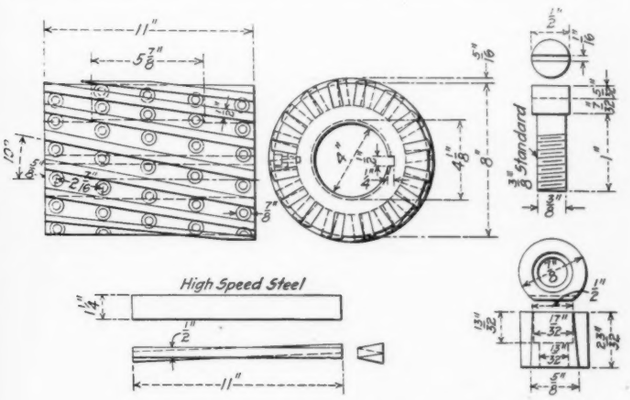


Fig. 8—Milling Cutter for Slab Milling

time. The illustration shows seven, one of the rods having been removed. The sides of the rods are milled in the same manner, two rods usually being milled at one time. The inserted tooth cutter used for this work is shown in Fig. 8. The body is made of axle steel and the 16 teeth are made of high speed steel. They are formed hot in a die to the shape shown in the drawing. They are inserted in corresponding slots in the axle steel body and are held in position by six thimbles having a tapered, flattened surface where they bear against the teeth. These thimbles are held in the body of the cutter by 3/8-in. machine screws. These cutters are 8 5/8-in. in diameter and 11 in. long. Three of them are used on one mandrel as shown in Fig. 7.

The main rods are handled in the same manner, with

the exception of the stub ends which are planed to within 1/32 in. of the required dimension, 1/64 in. from each side being removed on the vertical surface grinding machine. The channels are milled in one cut, three rods being channeled at one time on the large slab milling machine and two at one time on the smaller slab milling machine, as shown in Fig. 9. The milling cutters used for this work are shown in Fig. 10. They are similar in construction to those shown in Fig. 8. A center support made in the company's shops is applied to the machine to support the arbor

Fig. 9—Milling Channel Rods

carrying the cutters as shown in Fig. 9. Two of these supports are used when three cutters are used.

As an example of what is done by milling the rods, the following record of the milling of a channel main rod for a Consolidation engine is given:

Length over all	12 ft. 10½ in.
Length of channel	10 ft.
Width of channel	4½ in.
Depth of channel	1-25/32 in.
Weight of rod in rough	1,985 lb.
Weight of rod finished	690¼ lb.
Weight of rod with fittings	886½ lb.
Total weight of metal removed	1,295½ lb.
Weight of metal removed from channel	535 lb.
Time required to channel a pair of rods	8 hrs.

This work was done with three milling cutters. All slotting operations are reduced to a minimum as the experience

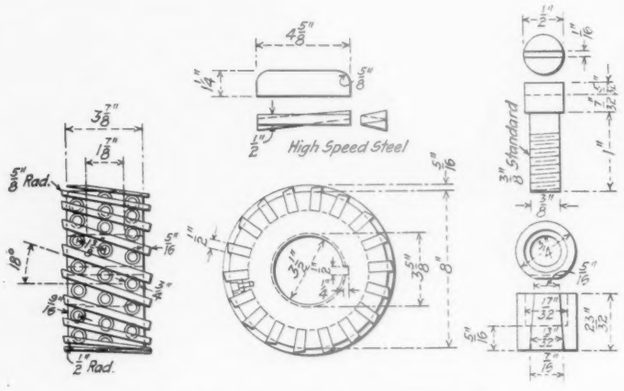


Fig. 10—Cutter for Milling Channel Rods

with the milling machine has proven it to be the cheaper practice. At the present time the slotting done consists of cutting out the rod for the pin brasses in the main rods and the knuckle jaw in the side rods. Plans are now being developed to cut out the back end of the main rod and the knuckle jaw on the milling machine. The rods are milled to size from the rough forging, only one cut being taken on each surface. The ends of the rods are milled on vertical milling machines.

MILLING TRAILER FRAMES

Another job well illustrating the value of milling operations is that of finishing trailer frames. No planing is done on them at all. Fig. 11 shows the amount of work required to finish these frames for a modern Pacific type locomotive. Two frames are milled on the flats at one time, eight are milled on the edges at a time and they are cut to length on a slotter, five frames being cut at one time. Fig. 11

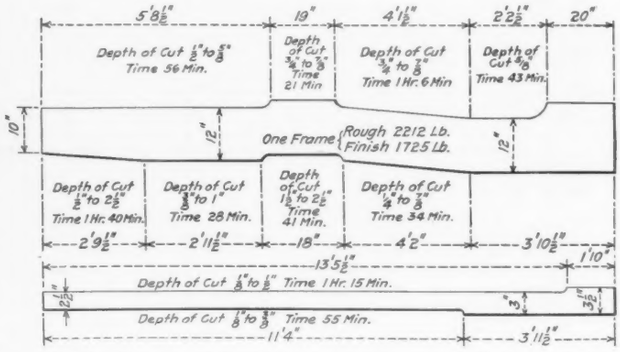

Depth of Cut ½" to ⅝" Time 56 Min.
Depth of Cut ¾" to ⅞" Time 21 Min
Depth of Cut ¾" to ⅞" Time 1 Hr. 6 Min
Depth of Cut ⅞" Time 43 Min.
One Frame Rough 2212 Lb. Finish 1725 Lb.
Depth of Cut ½" to 2½" Time 1 Hr. 40 Min.
Depth of Cut ⅜" to 1" Time 28 Min.
Depth of Cut 1⅛ to 2½" Time 41 Min.
Depth of Cut ¼" to ⅜" Time 34 Min.
Depth of Cut ⅛" to ½" Time 1 Hr. 15 Min.
Depth of Cut ⅛" to ⅜" Time 55 Min.

Fig. 11—Outline of Milling Work Done on Trailer Frames

shows plainly the depth of cuts taken over different parts of the frame. Only one cut is taken over the entire length. The weight of metal removed per hour of cutting time is 250 lb., and the amount of metal removed per hour is 961 cu. in. The following is a record of eight frames milled from the rough forging to the finished piece:

Amount of metal removed, edges	1,356 lb.
Amount of metal removed, flats	2,542 lb.
Amount of metal removed, total	3,898 lb.
Time taken to mill the edges	6 hrs. 29 min.
Time taken to mill the flats	8 hrs. 40 min.
Total time for cutting	15 hrs. 9 min.
Number of times the frames are chucked	13
Time taken to chuck the frames	26 hrs. 1 min.
Total time to finish the eight frames	41 hrs. 10 min.

Each frame weighed on an average of 2,212 lb. as it came to the machine as a rough forging and weighed 1,725 lb.

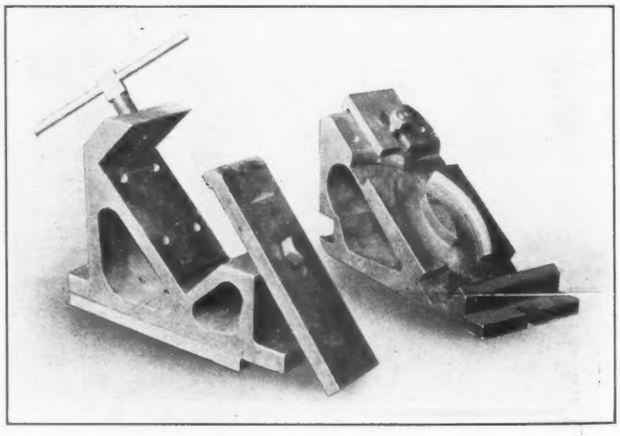


Fig. 12—Jigs for Milling Back End Main Rod Brasses

finished. Thus from each frame an average of 487 lb. of metal was removed in an average of about 5 hrs. and 9 min. from the time the work was started until it was finished.

MILLING MAIN ROD BRASSES

While the main rod brasses are planed for the rod fit and bored for the pin, the milling machine plays an interesting

part in the work done on them. The finishing of the brasses after they have been planed and bored involves the cutting of the inside corners, making the hard grease and oil grooves, rounding the corners of the flanges and cutting one flange away to clear the rod key set screws. This work was previously done as follows: The inside corners were cut on a shaper; the hard grease grooves were made on a slotter after holes at each end of the groove had been drilled on a drill press; the oil grooves and the corners of the flanges were chipped by hand at the bench, and the flange for the rod key set screws was cut on a milling machine.

Fig. 13—Milling the Inside Corners of the Main Rod Brasses

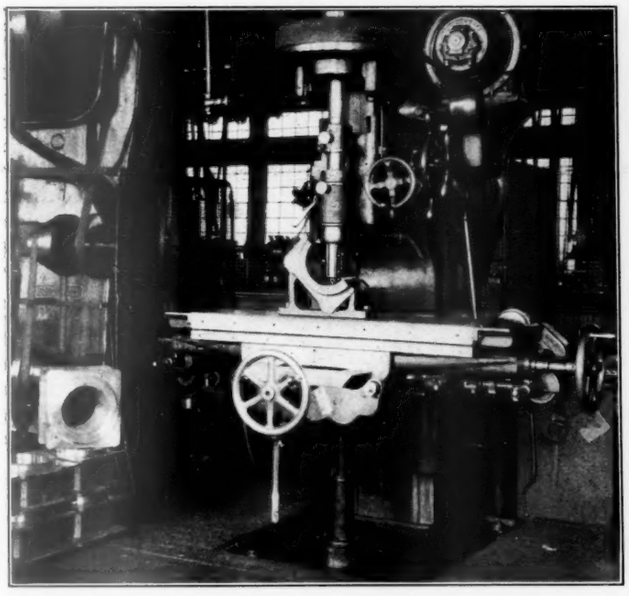


Fig. 14—Milling the Grease Grooves in the Main Rod Brasses

All this work is now done on a vertical milling machine with the aid of the jigs shown in Fig. 12. The inside corners are cut with an end milling cutter (Fig. 13) with the jig shown at the left in Fig. 12. The hard grease groove is made with a small end milling cutter as shown in Fig. 14. The oil grooves are made with a saw fitted on a taper shank and set in the spindle of the machine, as shown in Fig. 15. The jig shown at the right in Fig. 12 is used for holding the brass for this work. It is so designed that it will hold the brass on either side, which permits milling all diagonal grooves

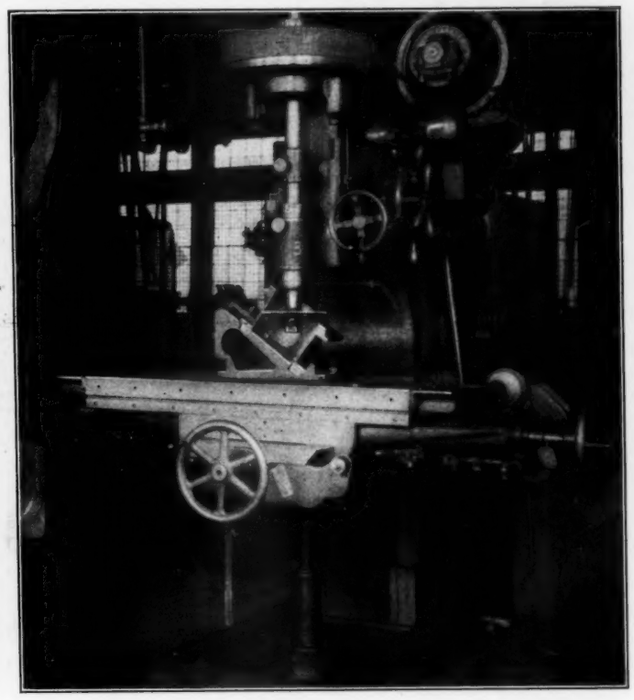


Fig. 15—Milling the Oil Grooves in the Main Rod Brasses

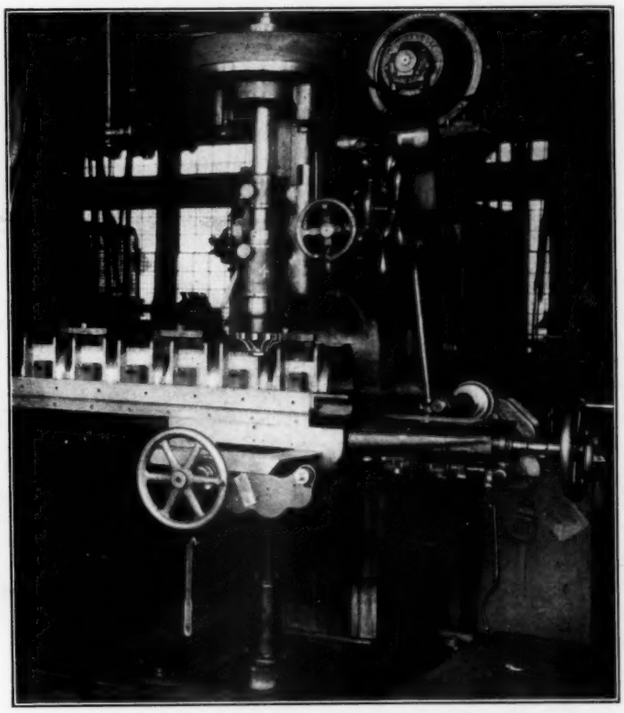


Fig. 16—Milling the Flange Corners of the Main Rod Brasses

with the same jig. The corners of the flanges are milled with a special design of end mill to give the proper radius and several boxes are set up at one time as shown in Fig. 16. The flange is recessed, as shown in Fig. 17 with a regular milling cutter.

By doing this work on one machine a large amount of time is saved by it not being necessary to carry the brasses to different places in the shop as was before necessary, and in addition to this, the cost of doing the work has been reduced materially, the work being done for 42 per cent of what was previously paid.

ACCURATE BRASS FITS

By finishing the back end of main rods on the surface grinder and planing the fits in the brasses to the micrometer with a .002 in. tolerance, a very satisfactory job is obtained and all bench work is eliminated. The only filing done is to remove the feather edges from the rods so that the hands of the workmen will not be cut. The work is done cheaper

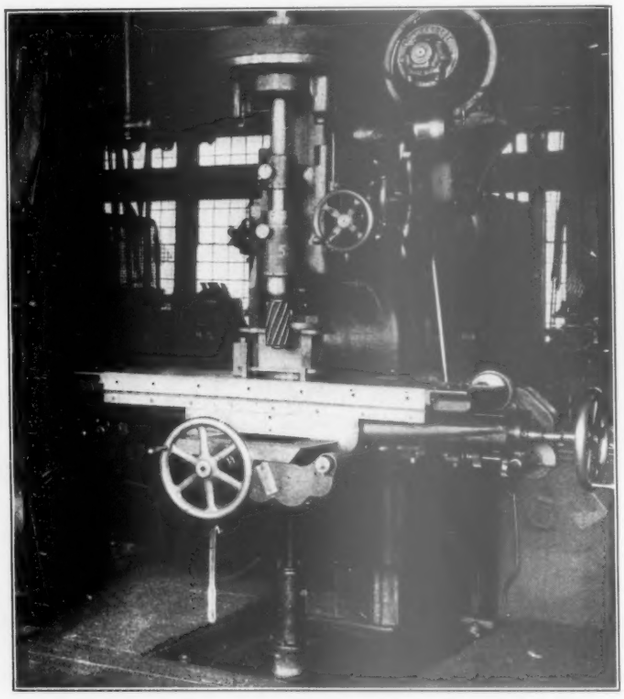


Fig. 17—Milling the Recess in the Flange of the Main Rod Brasses

by 30 per cent and the brasses are interchangeable with any rod of the same class of locomotive. The back end of the main rods are ground on the vertical surface grinding machine with the wedge block in place to bring it to the same thickness as the rod and the front end is ground with the brass in place. The accuracy sought in the brass fits is to limit the play between the rod and the brass to .005 in. The work is checked from time to time to impress upon the workmen that this tolerance must be observed, and the results of these inspections show that they are followed carefully. The last such inspection showed 80 per cent of the brass fits were within the .005 in. clearance tolerance and the greatest clearance was only .0085 in.

CONCLUSIONS

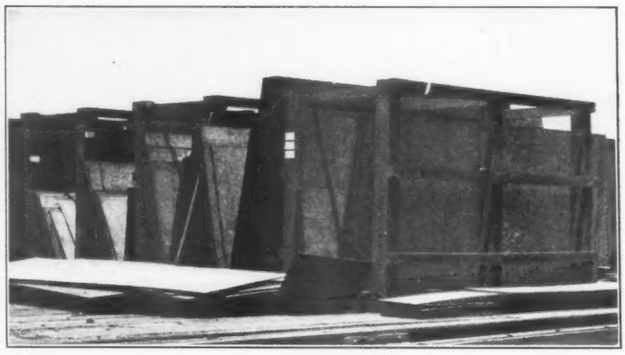
The purpose of this article is to show what is being done by the judicious use of grinding and milling machines in one shop, to decrease the cost of production and increase the shop output. The practices described will serve as a guide to those who have not gone as far in the application of these machines to their own shops. It is believed that much more can be done in both milling and grinding than is ordinarily done, and that the future will show a wider application of these machines to locomotive work.

RACK FOR STORING BOILER SHEET STOCK

BY C. L. DICKERT
Superintendent Shops, Central of Georgia, Macon, Ga.

The photograph shows a rack which has been built at the Macon, Ga., shops of the Central of Georgia for storing boiler plate and steel sheets. There are three such racks, each containing nine bents. Each rack is made up of five sections of framework, the intermediate bents being provided by the space between the adjoining frames. The sheets thus stored require much less platform space than when placed in flat piles on the platform. When piling sheets on the platform it was necessary to put sheets of different sizes and thicknesses in one pile, thus necessitating the handling over of considerable material in order to get at the size desired. With the present arrangement the sheets are lifted out of the rack by a crane, using a safety grip for holding the sheets. They are then carried on industrial trucks to the boiler shop.

It will be noted that the bents inside of each framework are closed at the top, the adjoining bents being open. Those



Rack for Storing Boiler Plate

which are closed are used for narrow sheets, while the larger sheets are stored between the frames.

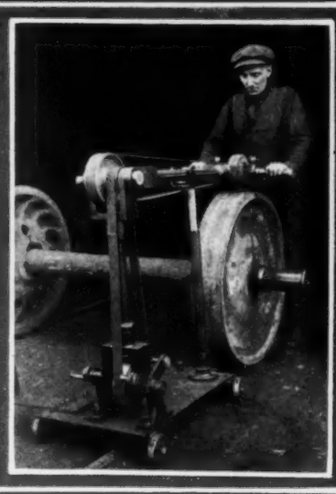
Each rack is built up on three 5½-in. by 9¾-in. stringers which form front, back and intermediate sills, to which the 5½-in. square uprights are secured by ¾-in. by 5-in. strap iron knees. The three uprights on each side of each frame are braced by 2-in. by 4-in. pieces placed horizontally. The sides of each frame are tied together at the top by 2-in. by 4-in. pieces. The uprights are about 70 in. in height and are spaced 36½ in. apart, the depth of the rack from front to back being 6 ft.

GASOLINE CAUTIONS.—Gasoline should be kept and used only in small quantities, and used only by experienced employees who realize the danger in using this volatile fluid and know how to handle it safely. Gasoline should be handled in small safety cans, equipped with safety gauze and safety stopper. Gasoline is exceedingly volatile and will vaporize when exposed to the air at any temperature down to 15 deg. below zero. This vapor is nearly three times as heavy as air, and when mixed with the proper quantity of air becomes violently explosive. The vapor will ignite from any open flame, even from a spark of static electricity from a human body, a spark from an emery wheel, or from a sufficiently heated surface. The gasoline vapor, being heavier than air, will naturally seek a lower level, and if confined where there is poor ventilation, will sometimes remain in an explosive condition for months.—*Compressed Air Magazine.*

Increasing Output and Reducing Unit Costs

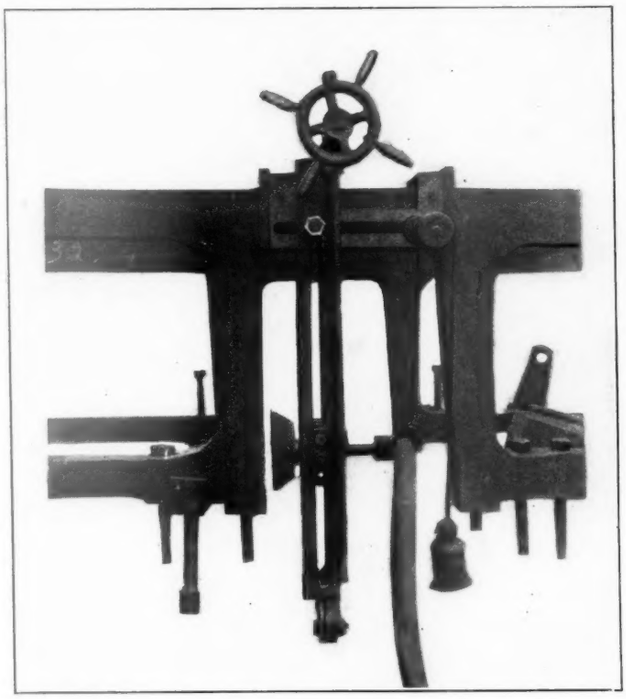
Grinding Processes Used as an Example

By E. J. Spidy
Formerly Shop Engineer
Canadian Pacific
Winnipeg, Man.



MACHINERY—strong as it is—is continually playing out, and each failure should be studied in order to make improvements. We are always interested in extending the capacity of machine tools by adding attachments or changing the construction details in order to perform some operation more efficiently.

Making a general survey of the various processes in our shops we cannot fail to note that progress is steadily being made that leads in one direction—to greater output and less cost per unit. For purposes of illustration consider the field of grinding. It would not appear that grinding had such a field in a locomotive repair shop as, for instance, in a manufacturing plant where new work is on the floor all the time, much of it being repetition work specially adapted to grinding operations. Nevertheless, during the past 12 months we have developed at least seven new applications of grinding, all of which are saving money under the particular conditions that each was designed to meet.



Pedestal Jaw Grinder In Place

FLEXIBLE SHAFT GRINDER

A flexible shaft grinder has been devised for use in the rod department to remove hammer marks on the straps of rod ends and for cleaning scale from straps and rods which are returned from the blacksmith shop. It consists of a countershaft mounted on a bench, to the end of which is attached a flexible shaft 1 in. in diameter, carrying a grinding wheel 6 in. in diameter and 2 in. thick; the wheel runs at a speed of 1200 r. p. m. Apart from a considerable reduction in the amount of labor, a large number of files are saved by its use. The strap or rod is set on a block at the end of the shaft, as shown in one of the photographs at the head of this article, and the operator grabs the handles on each side of the wheel and guides it over surface which is being ground.

SURFACING DIE BLOCKS

A device for surfacing or truing die blocks has been provided by attaching a grinding wheel to a vertical drill, as shown in one of the photographs. This may not be an ideal arrangement but it is the best that we could do with the material available. The forging machine die department is isolated from the main tool gang and it is often necessary to surface up dies after hardening because of warping and other reasons. In order to save considerable handling and many files we attached the fixture shown to the end of the spindle of a Foot-Burt drilling machine in the die department. It is locked to the spindle to prevent rotation. The fixture is a simple casting carrying a short spindle with a pulley for the drive on one end, and the grinding wheel on the other. An extra belt was run from the countershaft to drive the grinding wheel at a speed of 1500 r. p. m.

The die blocks which are to be surfaced are placed on the table and fed by hand across the grinding wheel; the vertical feed is obtained by means of the elevating screw under the table. This device has worked very well, but has the disadvantage of tieing up the drill, and we are now converting an old universal milling machine to do this work, as shown in the drawing. The miller has power cross feeds and we have only to connect a reversing gear mechanism to the feed and arrange a permanent spindle.

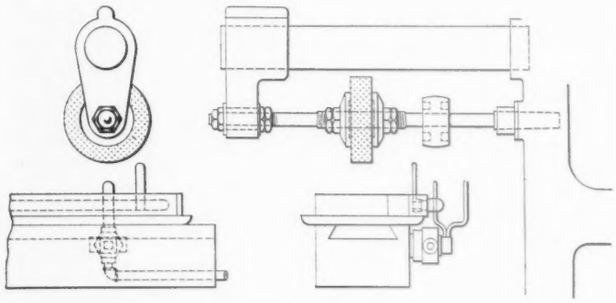
PEDESTAL JAW GRINDER

The horn or pedestal jaw grinder, illustrated in one of the photographs, is perhaps not in its final stage on account of difficulty in getting the correct size cup grinding wheel. It has been tested out with a smaller wheel than is desir-

able with results that are exceedingly encouraging and we are convinced that it will be a happy solution for what is one of the most awkward and tiring jobs in the locomotive erecting shop. It consist of a framework which carries the grinding wheel shaft and feed mechanism. A motor is hung on the opposite side of the locomotive frame and drives the grinding wheel by a flexible shaft. The grinding wheel itself is attached to a short shaft that is held in a bearing set between two slotted frames; these are, of course, longer than the frame jaws. A screw feed mechanism allows the grinding wheel to be fed up and down when the squaring adjustments have been made. There is also a screw feed adjustment for setting the gear up to the frame marks, and a separate feed for adjusting the grinding wheel on the jaw when the side guides are lined up to the frame marks. It is not difficult to set up the device and it promises to give a smooth and accurate finish, doing away with the tedious hand work.

TRUING WELDED SPOTS ON TIRES

A grinder for truing welded flat spots on tires is similar to the arrangement ordinarily used for side and main rod polishing. The grinding wheel is driven by means of a couple of belts on a double jointed frame, the drive being from a countershaft to the floor pulley of the machine.



Adaptation of Die Block Surfacing Arrangement to An Old Universal Milling Machine

Handles on each side of the wheel allow it to be readily guided over the welded spot. This saves much labor, files and violent language because the flat spot is built up of wheel turnings which are often harder than the files. A drawing of this device will be found on page 212 of the April, 1917, issue of the *Railway Mechanical Engineer;* a photograph is also shown in the right hand view at the head of this article.

RAIL SAW GRINDER

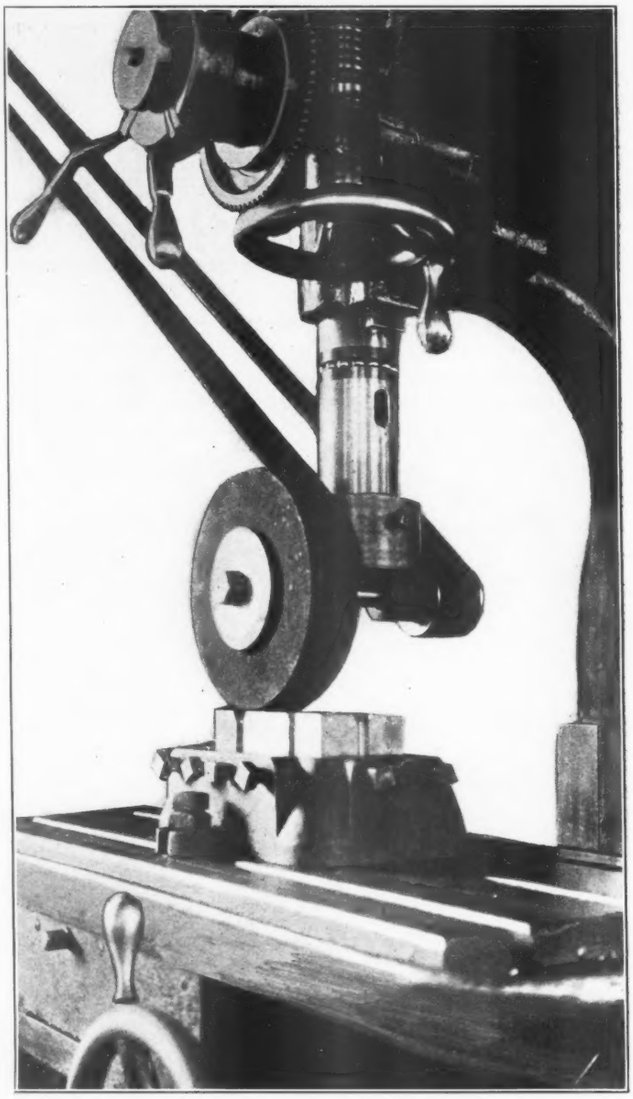
The saws used on the rail saw are made of one-quarter-inch boiler plate and after a time the corners wear off. They may be much improved by being squared up again on a grinder. In order to do this a triangular table has been rigged on the tool grinding level of regular double floor grinder which is near the rail saw. This may be set up in less than ten minutes; a saw to be sharpened is dropped on the pin at the apex of the triangle frame and fed into the grinding wheel; it is turned by hand; this trues up the edges and at the same time keeps them true to the circle.

MOTION WORK GRINDER

The flexible grinder in the rod department suggested the use of a small surfacing attachment for the use of the motion work gang; this in order to rough grind work from the blacksmith shop before using a file on it. In this case the work is mostly small and a solid stand with a wheel 10 inches in diameter and 3 inches wide was equipped with an adjustable table over the top of the grinding wheel. The table may be adjusted so that just enough wheel projects to grind lightly the surface of the link blocks or other parts. Babbitt packing rings are also surfaced on a machine of this type.

GRINDING IN CYLINDER HEADS

The arrangement for grinding in cylinder heads has also been improved, and was illustrated and described in the *Railway Mechanical Engineer* of November, 1916, page 595. We had been using a mechanical crank motion for this operation for some years but the new arrangement does



Grinding Arrangement for Surfacing Die Blocks

the work more quickly and is better because the grinding wheel is driven at a more suitable speed. For the air motor and crankgearing a Westinghouse air pump was substituted on a suitable frame. The back end of the pump is on a fulcrum and oscillates as the cover is moved back and forth.

Cast Iron Cement.—A cement for patching cast iron may be made of 16 oz. of finely pulverized cast-iron borings, 2 oz. sal ammoniac, 1 oz. sulphur. Mix well and keep dry. To use, take one part of the mixture to 10 parts cast-iron borings or filings and add enough water to make a stiff paste and calk it into the crack or hole to be repaired and let it set for 24 hours.—*Power.*

LOCOMOTIVE ROD JOB

Prize Winning Papers of the Rod Job Competition Which Closed May First

[Several contributions were received in the rod job competition. That receiving the first prize is given below. The others will be published in future issues.—Editor.]

ORGANIZATION AND METHODS FOR HANDLING RODS

BY ERNEST A. MILLER

The following is an outline of the manner in which the locomotive main and side rods may be handled economically and with despatch. The organization and plan of the machine tools is adapted for handling from 30 to 40 sets of rods of the average locomotive per month.

ROD GANG ORGANIZATION

The chart shown in Fig. 1 outlines the organization of the rod gang. In a gang of this size the foreman should

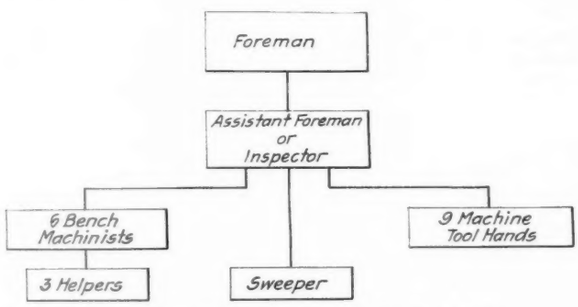


Fig. 1—Organization Chart for the Rod Gang

have an assistant foreman or inspector who should be a capable man. The six bench machinists should have three helpers, one to assist two men. The helpers remove rods from engines, clean them and deliver them to trestles at the machinist's bench for inspection and repairs. They obtain the material from the stock-room to repair the rods, take care of the crank pin and knuckle pin nuts and washers which have been removed with the rods, and do all the moving of the rods to and from the smith shop, machines and trestles and assist the machinists generally.

The six machinists should take care of both side and main rods of five to seven locomotives a month per man. Each man should take his turn as an engine comes into the shop, and he is held responsible for all repairs to both the main and side rods on that particular locomotive.

The chart also shows nine machine men, a majority of whom are first class machinists or machine hands. These men handle all the machine tool work to be done on the rods. Their duties are outlined according to the machines on which they work.

LAYOUT OF SHOP FOR ROD WORK

The arrangement of machine tools and benches is shown in Fig. 2. At the top and on the right is shown a bench for the helpers in which they store their oil, waste, wrenches, etc. Next is a bench for the six rod machinists. This bench has a chipping screen in the center 3 ft. high and it extends the entire length of the bench. Each man has a pair of trestles at his bench to hold several pairs of main rods on which he may be working and as the main rods are seldom taken off these trestles after being once put on them there is no necessity for a crane. By using the wagon shown in Fig. 3 they can be hauled to the trestle, lifted one end at a time and slid onto it. The machine

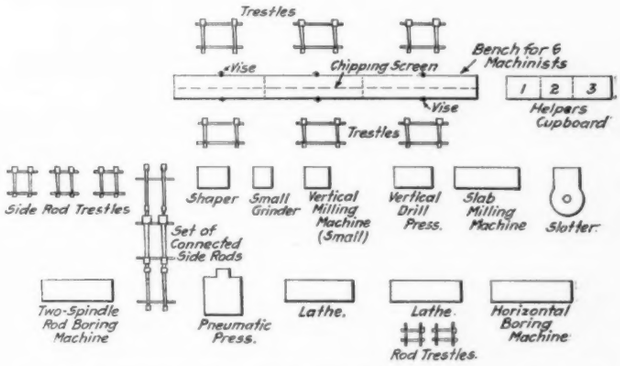


Fig. 2—Arrangement of Tools and Benches for the Rod Job

tools are located conveniently to the rod-men's benches. The work done on these machines is as follows:

Large Lathe (*20 in. to 25 in.*).—On this lathe all the brass bushings are rough bored and faced for stock, and when they are to be applied they are bored to fit the rods and faced to the proper width. All pin brasses are also bored and the back end main brasses are faced.

Drill Press.—This machine is used for drilling pin holes in all bolts, crosshead pins, knuckle joint pins and the oil

holes in the side rods and knuckle joint bushings. It is also used for drilling holes in the new main rods and the new side rod jaws preparatory to slotting.

Small Lathe (14 *in. to* 18 *in.*).—All knuckle joint pins and bushings are turned and bored on this machine.

Shaper.—All brasses, keys, wedges and blocks are handled on this machine.

Slotter.—The slotter is used for slotting the jaws and for outlining around the ends of the side and main rods.

Milling Machine, (*small, vertical.*).—This machine is used for milling keyways for set screws in keys or wedges,

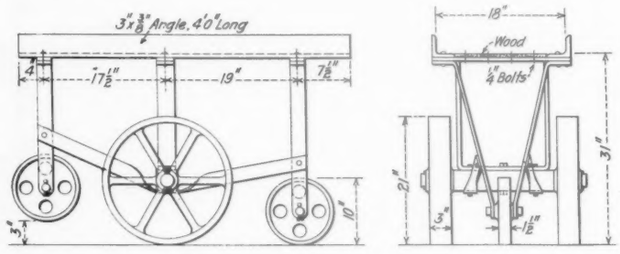


Fig. 3—Wagon for Carrying Locomotive Rods

for cutting the wrench fit on the end of newly made grease cup plugs, and for rounding one side of front end keys.

Milling Machine, (*large*).—This is used for milling rods to the proper thickness, and for milling the new back end main rod brasses in lots of four and six as desired, they being clamped to an angle plate.

Horizontal Boring Machine.—This machine is used for boring large holes for brass and steel bushings and for finishing the outside of grease cups on new rods.

Rod Boring Machine.—This machine is used for truing up knuckle joint bushing holes that are out of round, for boring bushings and for drilling holes through them for grease sockets.

The large lathe, on which the large brass bushings are

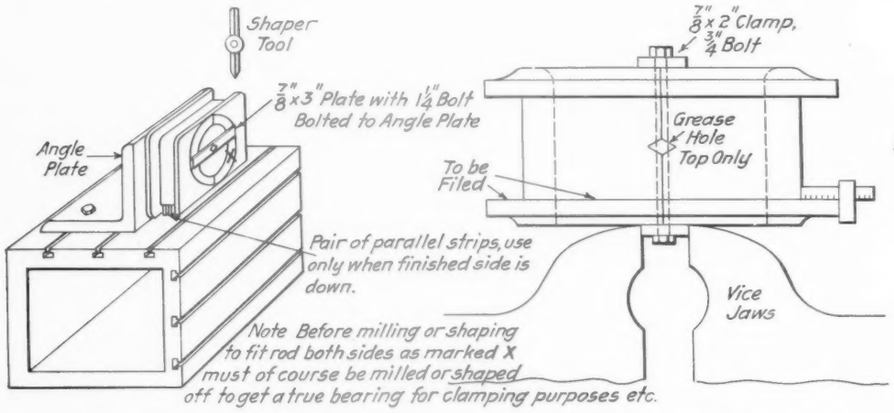

Shaper Tool
7/8"x3" Plate with 1 1/4" Bolt Bolted to Angle Plate
Angle Plate
Pair of parallel strips, use only when finished side is down.
Note Before milling or shaping to fit rod both sides as marked X must of course be milled or shaped off to get a true bearing for clamping purposes etc.

Fig. 4—Holding Brasses on Slotter Table

Fig. 5—Holding Brasses in Vise for Filing

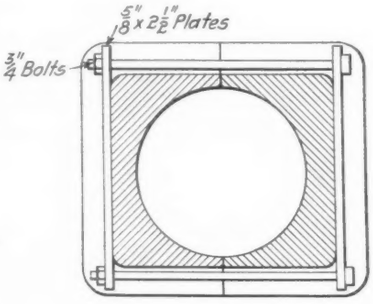


Fig. 6—Clamp for Holding Brasses for Boring

finished, is located near the press, so the bushings may be pressed in after they have been turned. The rods are then laid on four 8-in. blocks near the press for boring. The rod boring machine is also located nearby. After the bushings have been bored in the side rods they are placed on trestles to have the grease grooves cut and grease cups fitted, and to be made ready for the engine. Near the small lathe, two or four trestles are located on which the side rods having jaws, are to be placed so the lathe man can fit the knuckle pins. Any reaming necessary prior to this, of course, can be done on the rod boring machine. The small grinder shown in the machine tool layout is operated by each bench-man who in any but very large shops, should grind his own pins for the set of rods on which he is working. No grindstone or emery wheel is shown as it will be understood that such will be found in any shop. If the rod work can be situated where it can be under the travel of an overhead crane, so much the better. A cast iron V-block should be placed near the lathes for inserting mandrels in the large bushings.

While local conditions will govern to some extent the arrangement of tools for the rod work the above shows a logical layout that will expedite the work.

REPAIRING MAIN RODS

After the main rods have been removed from the locomotives they should be completely dismantled and cleaned in the lye vat or with oil and waste. Both the rods and the brasses should be carefully examined for cracks. The good back end brasses should be babbitted if there is too much clearance between them and the jaws of the rod, being chipped and filed to make a good fit. The old brasses that are to be used again should each be closed 1/16 in. for reboring. Unless the front end brasses have been renewed recently, they should be renewed if the engine is getting general repairs.

Fitting New Back End Brasses.—The new back end brasses are taken from stock with the two halves which have had their joining sides trued up on a shaper, sweated together. The sides are then faced in a shaper or milling machine to within 1/8 in. or 3/16 in. of their standard thickness. They are next machined to fit the rods. Where a number of brasses for rods of the same type are to be machined the work can be done quicker on a milling machine, several brasses being done at one time. Care must be taken in setting them up so that they will have the proper alinement. Where but few new brasses of one size are required it would not pay to have a milling machine for fitting new brasses, as too many cutters of various widths would be required, besides the trouble in preparing machine, etc. A shaper would, under these circumstances, be better suited for this work. Fig. 4 shows how the brass is clamped to the angle plate on a shaper. After the one side is finished the brass is given a quarter turn and the second side is cut, it being squared with the finished side. Two parallel strips are placed under the finished surfaces for squaring the brass for finishing the other two surfaces.

After being shaped the brasses are filed on the flanges to fit the rod. As the two halves are still attached to each other, a clamp is bolted to them and they are held in a vise as shown in Fig. 5. After the filing is done the clamp is removed and the corners of the front half of the brasses are rounded to fit the rod. The brasses are then broken

apart and stenciled right or left and the engine number is stamped on the outside side of the brass. They are then bored in the lathe, the clamp shown in Fig. 6 being used for holding the two halves together. A pair of parallel strips is placed between the brasses and face plate of the lathe and a pipe center in tail stock is run up against the brasses holding them in place until they are clamped. They are also faced to the proper thickness on this machine.

The rod man then fits the brasses on the pin and files the top and bottom of the bore, where halves meet, for clearance, so they will not pinch when bolts are tightened. A *V* is cut in each half at the top for the grease to pass

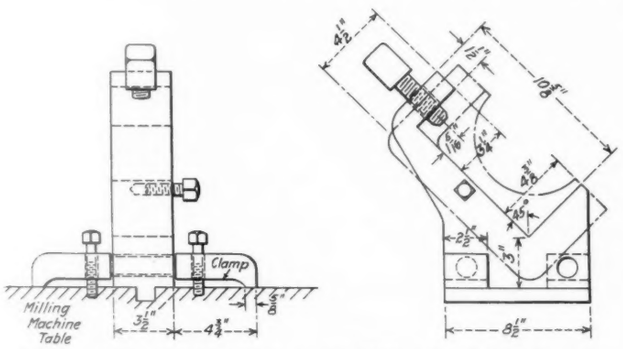


Fig. 7—Jig for Holding the Brass for Milling the Grease Grooves

through to the pin from the grease cup. The inside corners directly above the brass are also chipped away to within ¼ in. of each side of the brass to permit the grease to spread out over the pin. Two grooves for retaining the grease are milled with a special round nosed end mill toward the corners, as that is the thickest part. Fig. 7 shows the jig for holding the brass while this is being done. After filing off any burrs, the back end brasses are ready for application to the rods.

Fitting New Front End Brasses.—The new front end brasses are held in stock with the two halves sweated together in a manner similar to the back end brasses. They are machined on the shaper before being placed in stock. When they are to be used they are laid out and the corners rounded, roughly on an emery wheel. They are then filed to a fit. The back half is fitted first, as it has two small flanges which fit over the wedge block. Fig 8 shows a jig for boring the brasses. It is clamped to the face plate of lathe, parallel strips being used to provide a clearance for cutting tool. The brasses are inserted and held in position by the two set screws and wedge.

Any size of brasses can be bored with this jig, and they can be set up without removing the jig from its position. The one key has a lip on it to prevent it from dropping from the jig. A *V* is cut in each half and about 3/32 in. is chipped from each adjoining edge so that as they wear they can be keyed up without striking each other. A cupped washer is used on the front end key to provide a clearance for the body of the key as it is drawn in as the brasses wear. This cup also serves to hold the thin liners placed between the key and the block, the tapered end being bent over and under the cup. It is recommended, however, that all front end liners be riveted to the key as otherwise they may get lost and cause trouble.

The striking points of the piston should be taken and marked on the guide. The travel of the crosshead is made to come within these points by the adjustment of liners in either the back or front end brasses of the main rod.

MAKING NEW MAIN RODS

It is easier and cheaper to make new main rods two or more at a time. The sides of both the front and back ends are planed or milled. They are then laid out, drilled, slotted and the long central part milled and fluted. After the sides of the front and back ends are milled the rods can be laid out while on the same milling machine and the body milled and fluted before they are removed from this machine. This will save handling. The rod then goes to the drill press, where holes in the corners of the opening for the front end brasses are drilled at both the front and back ends. The rods are then taken to a slotter and slotted out two at a time. After the back end is slotted out, two holes are drilled both at the top and bottom, and cut out for the wedge bolt and wedge. The large back end blocks can be made cheaper by planing up long slabs, planing the keyway in them and then sawing them off to the proper length on a cold cut saw or a slotter.

The front end main rod key blocks can also be started in a similar manner and after being cut off, they are finished in pairs on the shaper.

Set screws with a thin head for clearance, are required for both the front and back ends. They should be turned down at the end so that they may be removed easily and they should be hardened.

The next operation is turning the oil cup and drilling the oil hole on the front end and the grease cup at the back end. A hollow end mill is used for this work. The back end grease cup is tapped out and the screw plunger with a nut for tightening is applied. Two stiff brass wires 3/32 in. in diameter are inserted and riveted into the cup at the front end. Under these a small quantity of hair is tightly inserted to hold the oil and prevent dirt working into the bearing.

The wedges should be milled on both sides for the set screws, so they can be used on the right or left side of the

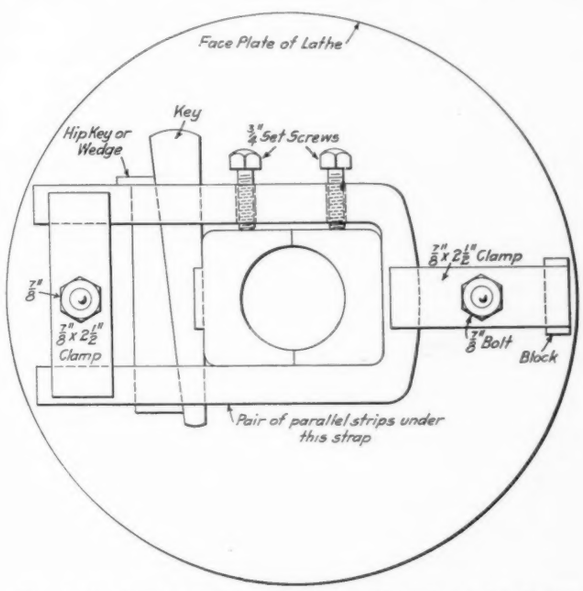


Fig. 8—Jig for Holding the Front End Main Brass for Boring

engine. They can be milled by setting up two at one time with the tapered faces together. This will bring the surface to be milled parallel with the bed of the machine. This also applies to the front end keys which should be milled on both sides for set screws so they can be used right or left. The half round side of the back end wedge bolts and front end keys is machined by means of a radius attachment on a shaper.

REPAIRING SIDE RODS

The plugs and bushings are removed from the side rods as soon as they are removed from the locomotive and the side rods are cleaned and inspected. Those parts of the

rods at which the cracks are most likely to occur are examined with a magnifying glass. The bushed holes are examined for roundness and if worn too much out of round they are rebored, or if they have been rebored to the limit a new end is welded on.

The jaws and stub ends, which become more or less worn, are filed true. The rods are connected up for alinement test and any resetting is done in the smith shop. The jaws are reamed for the knuckle joint pins and the holes for the knuckle joint bushings are trued up by reboring if necessary. New knuckle joint pins and bushings which are kept in stock ready to be fitted, are finished for the rods and casehardened over night. The bronze bushings which are kept in stock, rough bored with one side faced and the bore rounded for the crank pin fillet, are then put on an expanding mandrel and faced to the proper thickness and turned to fit the rod, one side being slightly relieved to start it in the rod.

The bushings are then pressed in the rods with an air press, white lead or oil being used on the bushing. Before pressing any bushings in, especially brass bushings, any burrs that are in the hole should be filed off as they will cut the bushing so it will become loose in a short time. The knuckle joint pins are ground to properly fit the steel bushings. The rods are then laid on some small blocks and connected to each other, the knuckle joint pins being driven in tight. Short pieces of wood are inserted in the pin holes on which the center of the holes are located. The rods are then trammed for length. If none of the centers are over ⅛ in. out, scribe a circle on the bushing accordingly and center punch it for locating central when boring. If they are over ⅛ in. out of center, scribe a circle from

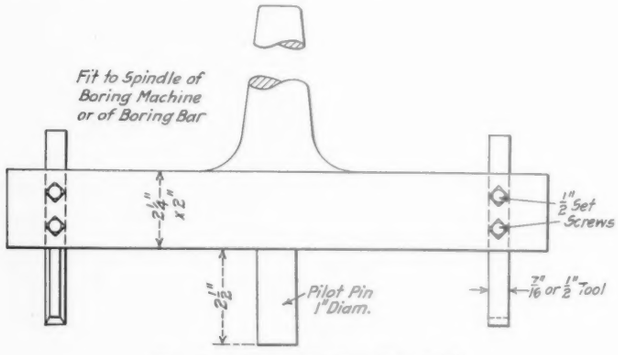


Fig. 9—Tool for Boring Side Rods

the true center of the bushing, center punch it and have the rod lengthened or shortened as the case may require.

The bushings are bored on a two spindle rod boring machine. While one is being bored the operator can be getting the other started. It is this man's duty to caliper the pins and bore the bushings accordingly. Almost any good sized vertical drill press can be fitted up for doing this work, but in a large shop the two spindle rod boring machine would pay for itself by increasing the output.

The oil and grease grooves are then chipped and all burrs are removed. The fillet of the bushing is then carefully filed. The plugs which hold the bushings in place are screwed in and the grease cups are fitted and their operation inspected. The rods are then taken to the locomotive and applied. Generally the left crank pin is one-quarter turn ahead of the right, in which case it is placed on top quarter which would make the right side on the back center. It would be practically impossible to get the rods on the right side if the left ones were put on first, as to move a pin ⅛ in. forward or back on the right side would cause possibly a ½ in. movement of the pin of that wheel on the left side and that would throw that side too far out. In this case the right side should be put on first and then the left can be put on.

The helper should look out for the crank and knuckle pin washers, nuts and taper pins. The mechanic in charge of the job should see that there is a scant 1/16 in. side play and he should also screw down the grease cups until grease

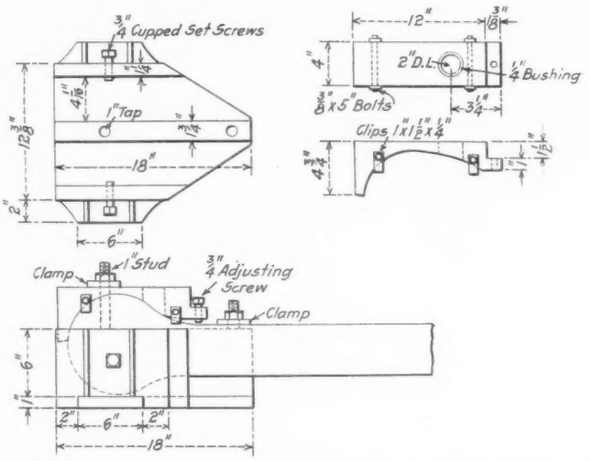


Fig. 10—Jig for Drilling the Knuckle Pin Connection for Slotting

comes out somewhere from around the pin and then refill the cups.

MAKING NEW SIDE RODS

The side rods should be made in multiples of two as they can be made cheaper in this way. They are handled in a manner similar to that of the main rod. After being milled on the flats and laid out and the edges milled, the ends are finished on the slotter, two or four being handled at one time. The crank pin holes are then bored out. Fig. 9 shows a tool for doing this work. It is made in one piece. The part that holds the tool is 2 in. by 2¼ in. The tools are 7/16 in. or ½ in. thick and are held in place by two set screws. The shank is made to fit spindle of boring machine. A one inch hole is drilled entirely through the rod for the pilot pin. This pin enters the work for about ½ in. before the tools start to cut. The cut is carried through half way and the rod is turned over to finish the cut. After the metal has been removed a light finishing cut is taken with a boring tool.

The knuckle pin ends of the rods are then finished on the flats. The grease cups are handled in a manner similar to that described under new main rods. The slot in the ends of the side rods for the knuckle pin connection is made with the aid of the jig shown in Fig. 10. This is used for drilling the jaw prior to slotting. This jig consists of a casting with a 1¾ in. wall in the middle and a 1¼ in. wall on the sides with openings 4 1-16 in. wide. The rods are placed on each side of the middle wall, being held against it by ¾-in. set screws through the outer walls. A steel drill-guide shaped to fit the rod is placed on top of each rod and is held in position by a clamp as shown, an adjusting screw at the right of the guide being set to properly locate the hole. The hole in the guide through which the drill passes is provided with a hardened steel bushing. Clips are provided on the drill guide to center it on the rod. After being drilled, the jaw is cut out on the slotter, two cuts being necessary. A tool 7/16 in. or ½ in. wide is used for this work and after the metal has been removed a tool of standard width is used for finishing. After this jaw is slotted the hole for the knuckle pin is drilled and reamed and dowel pin hole cut in. The pressing in of the bushings, fitting knuckle pins, etc., is the same as described under "Repairs to Side Rods."

MILLING MACHINES IN RAILROAD SHOPS

Classes of Work for Which They are Fitted. Cutters of Proper Design is an Important Consideration

BY HARVEY DE WITT WOLCOMB

THE great variety of work done in a railroad machine shop demands an equipment that will not only be adapted to turn out jobs economically, but also to handle many different forms of work on one machine.

It has been proven that it is really a saving in some instances to make castings with plenty of stock so as to be finished for different shapes of work, thus putting it up to the machine department to remove the surplus stock both quickly and economically. One large manufacturing concern has discontinued the careful making of patterns for iron castings, and simply casts a rough piece somewhere near the required shape so that the machine department can produce a finished piece. With the use of the planer or shaper, this surplus stock means more cuts, which in turn means added time for finishing, but with the milling machine the amount of finish has very little bearing on the time taken to turn out a job.

In locomotive repair work, such as machining side and main rods, guides, or other parts which require a neat finish, it was the policy to plane and then draw file, but this has been eliminated by having the work done on the milling machine which gives a neat and accurate finish. Comparing the time taken to do the work, it has been found that the milling machine does a job much quicker and leaves the work perfectly smooth so that no hand work is required to remove rough edges. Panelling side rods is one of the jobs in which the milling machine has been questioned as to its true economy. Some roads claim it is more economical to recess the rod at each end and then plane out the stock in the center on a standard planer; however, when all things are considered, such as time to re-set, handle from one machine to the other, cost and upkeep of machine tools, it will be found that the milling machine is by far the better machine.

In describing the range of jobs that can be successfully handled on the milling machine, it may safely be said that it will "do everything but talk." While the milling machine is used more for removing material on straight pieces, or where curves are required, there are many jobs now handled on a lathe that could be done to better advantage on a milling machine. In automobile construction it has been demonstrated that it is more economical to revolve a piece of work once, having the material removed by a revolving milling cutter, than to have the same job handled in a lathe where there is only one cutting tool. Criticism of the theory of the milling machine may be more or less a matter of opinion, but based on actual results and backed up by the evidence of actual production, there can be no doubt as to what this type of machine will do.

Such jobs as machining crosshead gibs, shoes and wedges and other plain pieces of work, can be done to good advantage on the slab miller. A recent job assigned to this type of machine is the re-planing of guides, for in this case it has been found that the milling machine will machine the bearing side and both edges at one operation, and when completed will leave a finish far better than can be given with a planer.

The vertical miller is of course used for machining side rod ends, motion work hangers and other parts, and may be used to a good advantage to handle heavy jobs that are now done on a drill press. One job in particular is the milling of the dry pipe flue sheet joint on the front flue sheet, a job which has, as a rule, been handled on a boring mill or large drill press. To do this job on the vertical miller, it is first necessary to cut the joint to about the required shape with a regular boring tool and then finish with a large form cutter, sometimes called a "sun flower" reamer.

Such jobs as milling keyways in piston rods, rods, and valve rods has for some time been handled on the milling machine and has proved to be quicker and less expensive than the old method of chipping out by hand after being drilled.

CASEHARDENED CUTTERS RECOMMENDED

The making of and upkeep of milling tools is the one question where there can be any argument as to the economy effected with the use of this type of machine. Some shops claim that it is more economical to make high speed steel cutters, while others use the inserted tooth construction, and still others use a soft grade of steel and caseharden the tool. Of the three methods, the inserted tooth cutter and the soft steel casehardened tools are by far the better and give excellent service. Under the present conditions when it is imperative to conserve every piece of high speed tool steel, there should be no solid high speed tool steel cutters made, for even if the tool room mechanics are experts, many times a costly tool will last only a short time.

In making bolt cutter dies, it has been found that the high speed tool steel cutter is not a success, for it is almost impossible to get a perfect temper at the cutting edges, and this same argument holds good with solid milling machine cutters. As milling cutters wear rapidly, they should be made of as soft material as possible so as to be machined quickly in quantities and at a low cost; by using a soft material it becomes necessary to harden in some other manner than by drawing the temper. The best results for tools of this kind are obtained by the casehardening process which gives a hard tool and one that can be reground a few times before it becomes necessary to anneal and re-cut.

Many operators make the mistake of trying to operate the cutters at too fast a speed. A casehardened tool is very hard but will not stand high heat, and good results can be obtained by decreasing the speed and increasing the amount of feed. Every tool room has a pet theory as to the best manner of making tools and the kind of material that should enter into their construction but if the forces in charge of the tool room will experiment with casehardened tools made from scrap locomotive tires, they will find that it is possible to get splendid results.

One of the past serious drawbacks to the claims of the milling machine has been the cost of tools. It may be found that the tool room force is making tools at too great a cost to show economy in the operation of the milling machine. If such conditions are gone into thoroughly and ideas are developed to turn out cheaply tools that will stand up, the true worth of this machine will be proven. One trouble has been that the tool room foreman has been making tools from the tool room viewpoint, i. e., with no regard to the cost in comparison to the amount of work that will be performed. The average tool room force will object to the casehardened tool on account of the attention it requires, but when the cost is figured up in comparison with the amount of work turned out, it will be found that this type of tool is very successful.

There are many good standard types of inserted tooth milling cutters but no matter where you go, you will find the

tool room foreman trying to get up or re-design a milling cutter. Rather than to experiment thus, it is suggested that a certain type of cutter be adopted and made standard and then the tool room force exert its energies towards decreasing the cost of manufacture. The type of tool and the service rendered enter very much into the cost factors of turning out work on a milling machine; therefore this one item cannot be given too much attention.

The last point in favor of the milling machine is the claim of its accuracy, for milling tools can be set to gages so that the finished jobs will have exactly the same dimensions. For instance, if shoes and wedges are machined on a planer, the operator may make them a little full or a little scant of the desired sizes but with the milling machine with the inserted tooth cutters which are all ground to the same gage the work can be more accurately finished. Under the present conditions of rushing work through the shop, the machine hand does not always use care in taking his final cut so that jobs do not fit perfectly; with the milling machine, however, every job can be alike. As an example of this, a certain machine builder mills a hexagon fitted handle shaft so close that the handle easily slides on the shaft yet the vibrations of the machine will not jar the handle off. Try this job on a shaper or planer and see how easy it is!

While there are some jobs that cannot be handled to advantage on the milling machine, it is a fact that if a shop equipment was made up of the same number of milling machines as there are planers and shapers, the shop would be able to show a very largely increased output. Shop conditions will of course determine to some extent what tool is best suited for the local work, but with a battery of millers there will be very few jobs that cannot be handled to good advantage.

WELDING A CRACKED CYLINDER

BY JOSEPH SCHNEEBERGER

A Mikado type locomotive with 28-in. cylinders recently came into the shops with a crack through the steam port at the front end of the cylinder. The crack extended about half way around the barrel of the cylinder over the top. This was first repaired by chipping out the crack about 5/16 in. and filling it with copper, well hammered in. The cylinder was tested cold and showed no evidences of leaking, but when the engine was fired up and placed in service, the crack opened up again. To have patched this cylinder would have cost at least $250 and the following method of repairing the cylinder without the use of a patch was resorted to. The work did not cost over five dollars and did not hold the engine out of service.

A row of 13/32-in. holes, two inches apart, was drilled on each side of the crack and tapped out with ½-in. standard threads. Machine bolts ½ in. in diameter fitting snugly in the holes were screwed in tight and the projecting ends burned off with oxy-acetylene at a point ¼ in. above the surface of the cylinder casting. These projecting ends were then polished with a file and emery cloth. A strip of metal was then built up with the electric welder across the crack from the end of each bolt to the end of the opposite bolt in the other row. Longitudinal bands of metal were thus built up at intervals of two inches, the shrinkage as the welding proceeded, tightly drawing the casting together against the copper, which still remained in the crack. When the welding was completed it was found that the shrinkage had slightly warped the cylinder head joint. This was faced off with a boring bar and the engine placed in service. It has now been running for some time without any evidence of a leak.

At the present time several cylinders are being repaired by this method. One was cracked all the way down the back from the smoke arch to the exhaust port. This job has been completed and no evidence of any leak can be seen.

GAGES FOR DETERMINING THE LIFT OF AIR PUMP INLET AND DISCHARGE VALVES

BY H. S. WALDRON

The set of gages shown in the drawings is very useful to the air pump repair man in determining the lift of the air inlet and discharge valves of locomotive air pumps.

Fig. 1 shows the gages which are used at the lower valves. With the valve cage removed from the pump and the valve in place, the height of the valve from the face of the cylinder casting is determined by placing the legs of the valve gage upon the shoulder under the head of the cage and then running the adjusting screw down until it touches the top of the valve. The height of the valve stop from the face of the cylinder casting is then obtained by placing the body of the stop gage across the cage opening in the cylinder and running out the adjusting screw until the end touches the stop. With the two gages set together, the distance between the ends of the two adjusting screws will exactly equal the lift of the valve. If a new valve is to be applied the valve gage should be set to the stop gage, allowance being made for the desired amount of lift, and the valve ground off until the legs of the valve gage just touch the shoulder under the head of the cage when the valve is on its seat.

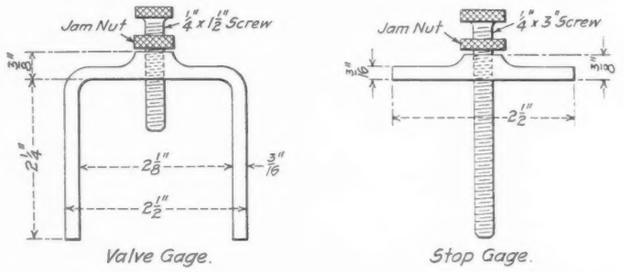


Fig. 1—Gages for Determining the Lift of Lower Inlet and Discharge Valves

In Fig. 2 are shown the gages for the upper valves. In this case the valve gage is set by placing the body across the opening in the air cylinder casting and running out the adjusting screw until the end just touches the top of the valve, the latter being in place on its seat. The height of the stop is obtained by placing the legs of the stop gage against the shoulder under the head of the valve cap, the adjusting screw being set to touch the face of the stop on the inside of the cap. By placing the two gages together the lift of the valve is plainly indicated by the distance between the ends of the adjusting screws. In fitting new valves to provide the desired lift, the valve gage is set to the stop gage, allowance being made for the lift of the valve. The valve is then ground off until the body of the gage rests upon the face of the cylinder casting with the end of the adjusting screw just touching the top of the valve.

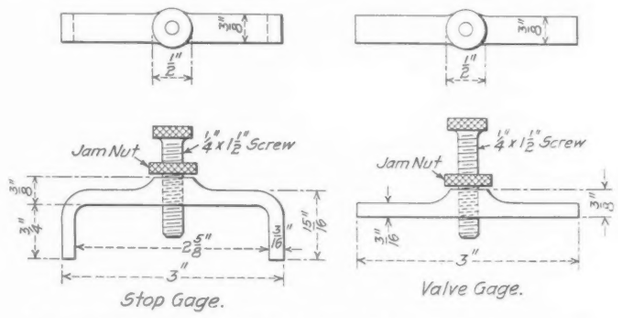
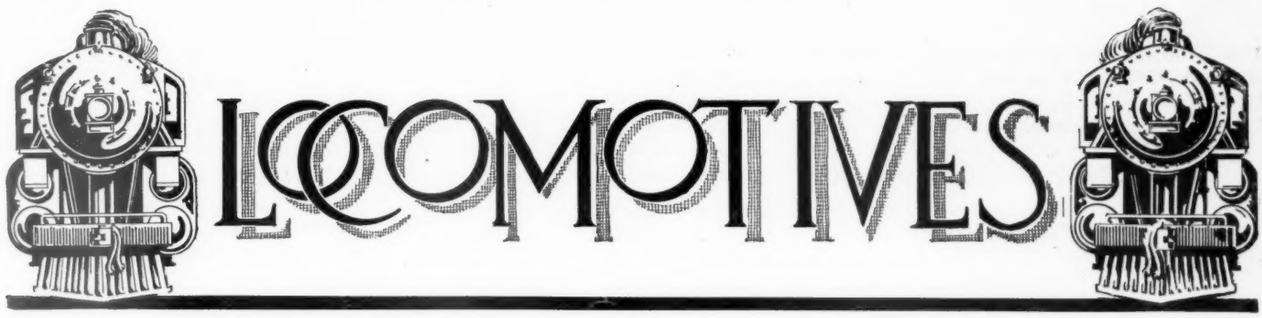


Fig. 2—Gages for Determining the Lift of the Upper Valves



LOCOMOTIVE FEED WATER HEATING*

How the Wasted Heat from Locomotives May Be Utilized in Preheating the Feed Water Economically

THE purpose of this report is to point out the benefits to be derived from the employment of preheat, to make known its source and the avenues of approach to the desired end, with illustrations of recent developments and practical results. As superheating is the final stage prior to the distribution of the product of the boiler, so is the preheating of feed water the initial stage closely approaching, if not equal to, the effective value of superheat, yet detracting in no wise from it. Preheat is now perhaps the one fundamental source of economy practically untouched in American locomotive practice, yet universally employed as an essential for stationary and marine boiler operation.

The economy, expressed in percentage of fuel saving, to be derived from preheated as compared to non-preheated feed water is in direct ratio as the temperature difference of the water before and after heating is to the difference between the total heat of the saturated steam at a given pressure and the final temperature of the preheated feed water. This may be expressed in the formula

$$S = \frac{100\ (t - t_1)}{H + 32 - t_1}$$

S = The percentage of saving from preheat.
t = The temperature in degrees F. after preheating.
t_1 = The temperature of the feed water before heating.
H = The total B. t. u. above 32° F. of saturated steam at the given pressure.

To obtain the maximum theoretical saving from preheating, the water must be brought up to the temperature of the saturated steam. With t less than the temperature of the saturated steam, and both t and t_1 constant, the percentage of saving varies inversely with the boiler pressure, increasing as the temperature difference between steam and water decreases. Hence it follows that with other conditions remaining constant, the higher the initial temperature, the greater is the percentage of economy per degree rise of preheat. The theoretical fuel saving from preheating is shown in Fig. 1.

PREHEAT AS RELATING TO LOCOMOTIVE OPERATION

From an operating standpoint, feed water heating is a pre-requisite to the best performance and maximum locomotive efficiency. The introduction of comparatively cold water into the locomotive boiler reduces the effectiveness of the entire machine appreciably, especially on heavy grades, where almost invariably a drop in pressure results, often at a crucial moment when every pound the boiler can produce is needed. The utilization of preheat permits a freer steaming boiler, confidence is instilled into the fireman and a better "job of firing" is obtained, with consequent increase in locomotive capacity.

* An abstract of a committee report of the International Railway Fuel Association presented at its 1917 convention.

It is evident that the earnings of a railroad are vitally affected by the efficiency of the motive power unit in reducing the cost of operating expenses and increasing the net operating revenues. Fig. 2 illustrates graphically the saving in dollars per annum per locomotive, at different rates of fuel consumption and varied cost of fuel per ton on engine tanks, in the use of preheated feed water.

BOILER MAINTENANCE

One of the most favorable aspects of preheating is its effect upon boiler maintenance, although it would be difficult to establish any definite relation existing between higher feed water temperatures and the decreased cost of maintaining boilers. The effect of preheating is to lessen the difference between the temperature of feed water injected and the temperature of saturated steam evaporated. A more uniform temperature throughout the boiler, resulting from feed water heating, will effect a greater reduction in strains upon the boiler than a considerable reduction in boiler pressure.

HEAT BALANCE

That a clear understanding of the principles underlying the construction and operation of feed water heaters may be had, it is advisable to review, in some degree, the subject of heat and its source and distribution in a steam locomotive.

The unit for measuring heat is a British thermal unit (B. t. u.). A B. t. u. is defined as 1-180 of the amount of heat required to raise the temperature of one pound of pure water from 32 deg. to 212 deg. F.

A pound of locomotive coal usually contains between 10,000 and 14,000 B. t. u. The distribution of this heat after it is liberated from the coal varies widely under different conditions. There is, consequently, a broad range of proportions of heat distribution from which to select an example for discussion.

Choosing one which will fairly represent attainable every-day practice on a properly proportioned locomotive of fairly large size and equipped with a superheater and brick arch, we find that 14,000 B. t. u. in each pound of coal could be distributed about as follows:

Lost to ash pan in unconsumed coal and heat in ashes		280 B. t. u.
Absorbed by firebox heating surface	3,780 B. t. u.	
Absorbed through boiler tubes	5,810 B. t. u.	
Total to water	9,590 B. t. u.	
Absorbed by steam in superheating	1,050 B. t. u.	
Total in steam		10,640 B. t. u.
Lost out of stack in hot gases, cinders, water vapor from moisture in coal and in incomplete combustion of gases		3,080 B. t. u.
Total		14,000 B. t. u.

It is seen that 10,640 B. t. u. or 76 per cent of the total goes into the steam. This is the boiler efficiency. It will

vary from less than 40 per cent to as high as 80 per cent in a reasonably clean boiler. Within the range of ordinary locomotive operation higher efficiencies accompany the lower rates of coal consumption per hour.

Investigating the distribution of this heat further, it will be found that the B. t. u. in the steam may be split up as follows:

To the drawbar to pull trains	980 B. t. u.
Used in friction of the locomotive	140 B. t. u.
Radiated from the whole locomotive (this includes radiation from the fuel bed)	420 B. t. u.
Used by the air pump (assumed)	840 B. t. u.
Discharged up the stack in the exhaust steam	8,260 B. t. u.
	10,640 B. t. u.

From these two tables it will be seen that 11,310 B. t. u. of the 14,000 B. t. u. in the coal, or 81 per cent, may go up the stack in form of hot gases, cinders, etc., and in the exhaust steam.

SOURCES OF PREHEAT

From the foregoing it is readily seen that the source of preheat is exhaust steam and waste gases, the potential energy of which must be utilized, at least in part, for preheating if useful work is to be obtained therefrom.

Exhaust Steam.—In exhaust steam there seems to be the greatest waste. Most of it, however, is unavoidable, a large part of the exhaust being essential to produce the draft required for rapid rate of combustion in the firebox.

Consider first what happens when heat is applied to water. For example, take a boiler under a pressure of 200

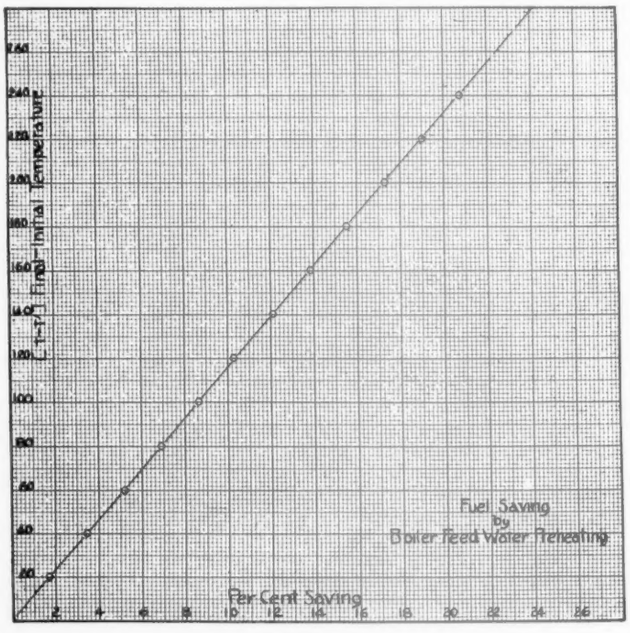


Fig. 1—Percentage of Fuel Saving by Feed Water Heating

lb., and feed water at 60 deg. temperature. The first effect is to raise the temperature of the water from 60 deg. to 388 deg., which is the boiling point of water under 200 lb. pressure. For a pound of water this will require, roughly, 388—60 or 328 B. t. u. (accurately, 333.4 B. t. u.). It is now at the boiling point, but none of it has actually been changed into steam. Continue the addition of heat, and it will gradually evaporate into steam, and when 837.9 B. t. u. have been added the original pound of water is all steam, but still remains at 388 deg. temperature. The heat that has been added without changing the temperature is called the "latent heat," and is really transformed in the work of the physical change in the structure from a liquid to a gas.

If the heat is continued after all the water is evaporated, the thermometer will again show the effect and the steam becomes superheated. The addition of approximately 111 B. t. u. will raise the temperature of the steam from 388 deg. to 588 deg., or a superheat of 200 deg. F.

For a pound of superheated steam under 200 pounds pressure and at a temperature of 588 deg. there is required about 1,282 B. t. u. if the feed water is 60 deg. temperature. Of this 837.9 B. t. u., or over 65 per cent, is the latent heat and simply keeps it in the form of steam. Therefore if steam is to be exhausted and not water from the cylinders all of this latent heat must be discharged, as well as the heat it took to raise the temperature of the water from 60 deg. to the boiling point at the exhaust pressure, amounting to over 88 per cent of the heat that goes to the cylinder.

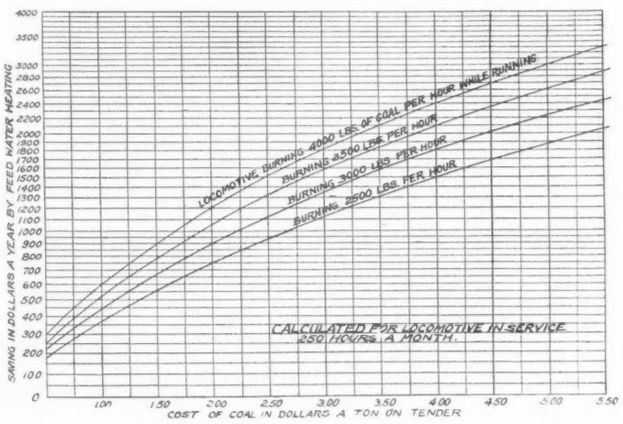

SAVING IN DOLLARS A YEAR BY FEED WATER HEATING
LOCOMOTIVE BURNING 4000 LBS. OF COAL PER HOUR WHILE RUNNING
BURNING 3500 LBS. PER HOUR
BURNING 3000 LBS. PER HOUR
BURNING 2500 LBS. PER HOUR
CALCULATED FOR LOCOMOTIVE IN SERVICE 250 HOURS A MONTH.
COST OF COAL IN DOLLARS A TON ON TENDER

Fig. 2—Amount of Money to Be Saved Yearly by Feed Water Heating

There must necessarily be some back pressure, and the higher it is the greater will be this percentage.

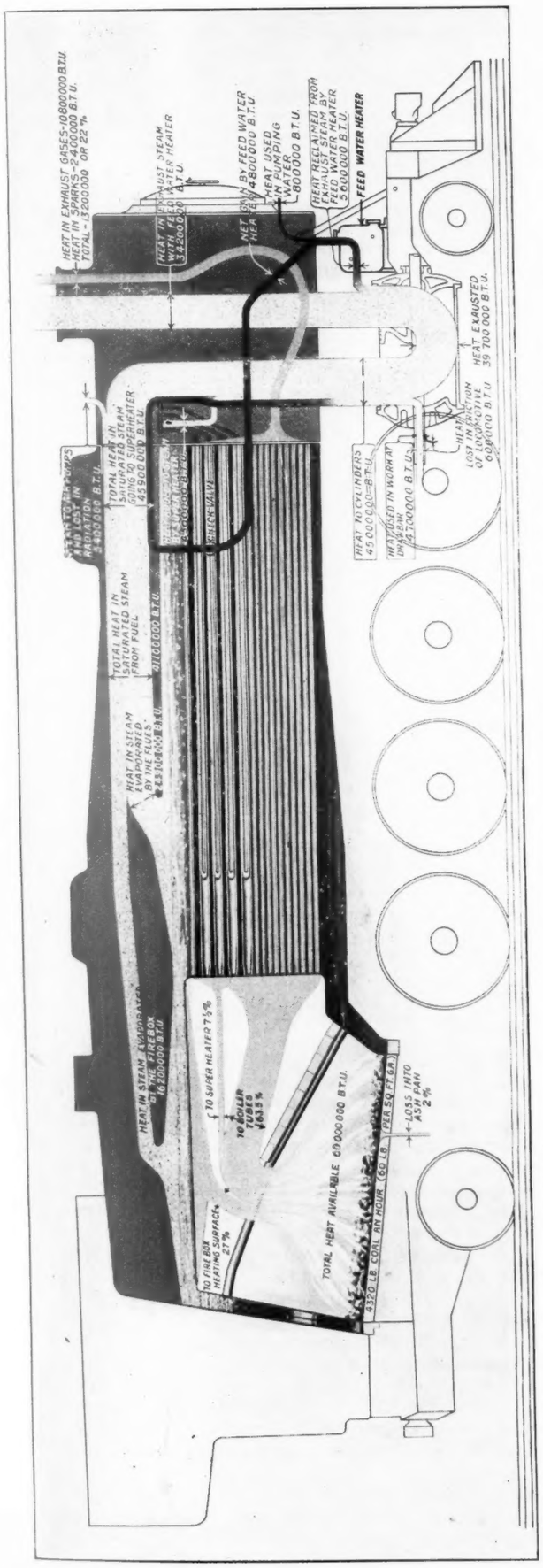
This latent heat, however, will all be given up if the steam is condensed back into water, and it is from this source that an exhaust steam feed water heater makes its saving. Thus with 60 deg. feed water and 10 lb. back pressure it is possible to use but about 16 per cent of the exhaust for feed water heating. The remainder must still be wasted until some hitherto untried method is conceived to use it.

Experiments have shown that the abstracting of 16 per cent of the exhaust does not in most cases require a reduction in the size of the nozzle to get the same vacuum in the front end and the same draft of the fire.

Table I gives in more detail the distribution of the heat in a normal locomotive. The first column gives the distribution where no feed water heater is used and the second column shows the distribution where an exhaust steam feed water heater is used. The coal is assumed to have a heat value of 13,808 B. t. u. per lb. of coal.

Fig. 3 illustrates graphically the effect of applying an exhaust feed water heater to a locomotive. It will be noted that the figures showing the B. t. u.s and percentages are the same as shown in the second column of Table I. The feed water heater is assumed to be abstracting 14 per cent of the heat in the exhaust steam. In both cases the same locomotive is considered and exactly the same amount of steam at the same pressure and superheat is supplied to the cylinders, and the same quantity of heat is used for work at the draw bar; likewise the same amount is discharged from the cylinders; yet on the locomotive equipped with the preheater only 60 lb. of coal per square foot of grate area is consumed as compared to 70 lb. where no heater is used, supplying 60,000,000 B. t. u. from the coal instead of 69,041,000, a net saving of about 15 per cent.

It will be noted in this table that some changes have been


HEAT IN EXHAUST 6455-1080000 B.T.U.
HEAT IN SPARKS-2400000 B.T.U.
TOTAL-3200000 OR 22 %
HEAT IN EXHAUST STEAM WITH FEED WATER HEATER 3420000 B.T.U.
NET GAIN BY FEED WATER HEATER 4800000 B.T.U.
HEAT USED IN PUMPING WATER 600000 B.T.U.
HEAT RECLAIMED FROM EXHAUST BY FEED WATER HEATER 5600000 B.T.U.
FEED WATER HEATER
HEAT EXHAUSTED 39 700 000 B.T.U.
HEAT LOST IN RADIATION OF LOCOMOTIVE 600000 B.T.U.
HEAT LOST IN WORK AT DRAW BAR 4700000 B.T.U.
HEAT TO CYLINDERS 45000000 B.T.U.
TOTAL HEAT IN SATURATED STEAM GOING TO SUPERHEATER 45900000 B.T.U.
TOTAL HEAT IN STEAM FED TO STEAM FROM FUEL
HEAT IN STEAM EVAPORATED BY THE FUEL
TO SUPER HEATER 7 %
TO BOILER TUBES 63.5 %
TO FIRE BOX HEATING SURFACE 27 %
TOTAL HEAT AVAILABLE 69000000 B.T.U.
4320 LB COAL AR HOUR (60 LB PER SQ FT GA)
LOSS INTO ASH PAN 2 %

(Copyrighted by the Locomotive Feed Water Heater Co.)

Fig. 3—Graphic Representation of the Distribution of Heat in a Locomotive Equipped with an Exhaust Steam Feed Water Heater

made in the proportions of the heat going to different points as shown in the second column, and that the proportion of the total heat in the coal that reappears as heat in the steam is different. This is true in actual practice, as has been shown many times by tests. It simply is an illustration of the fact that the lower rates of combustion on the grate are accompanied by a higher boiler efficiency, which condition has been mentioned previously.

It will be noted in Fig. 3 that a part of the heat coming from the feed water heater is shown as being wasted, and marked as the heat required for pumping. In this case it is considered that the steam going to the feed pump is exhausted to the atmosphere and lost. Actually, however, the exhaust from the feed pump is generally carried into the exhaust steam heater and condensed, a part of its heat being recovered.

Smoke Box Gases.—Irrespective of the use we may put exhaust steam to, we must still contend with smoke box waste. When the great volume of hot gas passing through the front

TABLE I.

Feed water Heater?	No	Yes
Rate of firing (lb. per hr.)	5,000	4,320
Coal fired per sq. ft. of grate area (lb.)	70	60
Total heat available (B. t. u.)	69,041,000	60,000,000
Percentage of total heat to firebox heating surface	27	27
Percentage of total heat to boiler tubes	64.5	63.5
Percentage of total heat lost to ash pan	2	2
Percentage of total heat to superheater	6.5	7.5
Heat in steam evaporated by firebox (B. t. u.)	18,641,000	16,200,000
Heat in steam evaporated by tubes (B. t. u.)	27,259,000	24,900,000
Heat in saturated steam going to superheater (B. t. u.)	45,900,000	45,900,000
Heat in steam lost through radiation and air pumps (B. t. u.)	5,400,000	5,400,000
Heat added to steam by superheater (B. t. u.)	4,500,000	4,500,000
Heat in steam fed to cylinders (B. t. u.)	45,000,000	45,000,000
Heat used in work at draw bar (B. t. u.)	4,700,000	4,700,000
Heat lost in friction of locomotive (B. t. u.)	600,000	600,000
Heat in steam exhausted from cylinder (B. t. u.)	39,700,000	39,700,000
Heat in steam exhausted from stack (B. ti. u.)	39,700,000	34,200,000
Heat reclaimed from cylinder exhaust by feed water heater (B. t. u.)	.....	5,600,000
Heat used to operate feed pump (B. t. u.)	.....	800,000
Heat lost in sparks and gases (B. t. u.)	17,260,000	13,200,000

end of a locomotive is considered, the possibilities of preheat from this source are apparent.

In ordinary practice the front end temperature is approximately 600 or 700 deg. F., while the temperature of the water in the boiler at 200 lb. pressure is 388 deg., and when the engine is working, the weight of heated gases may average two and a half to three times that of the water evaporated.

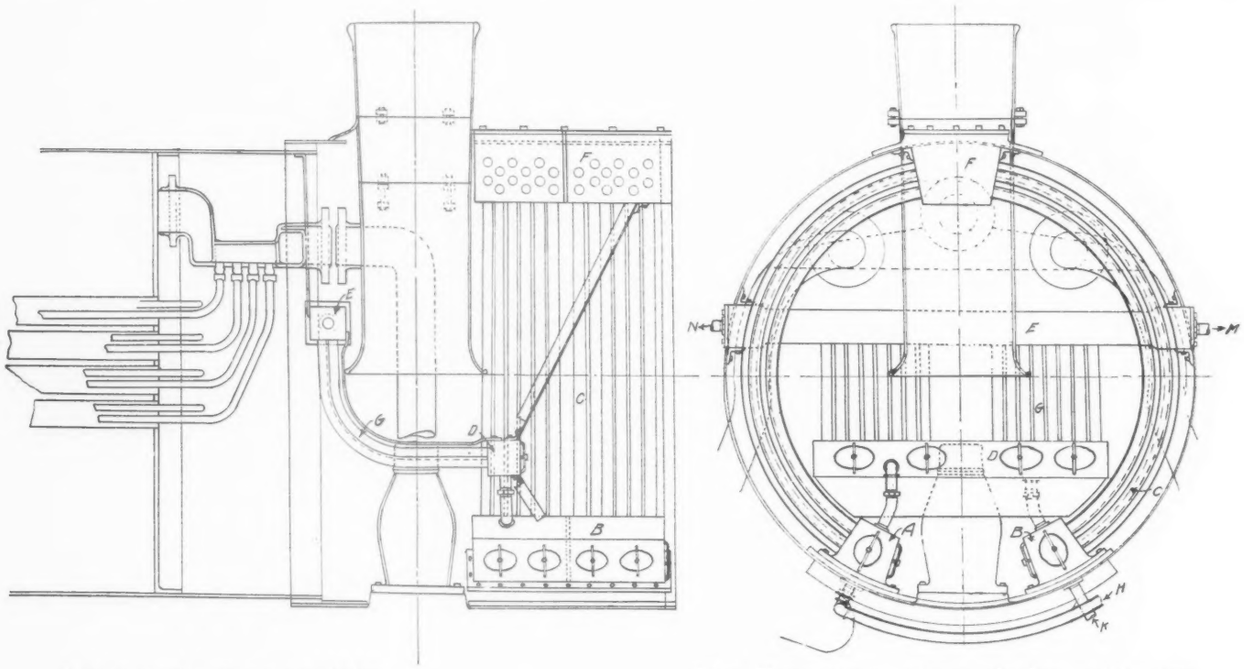
The heat transfer rate from hot gas to water is lower than that from exhaust steam to water per square foot of heating surface, likewise the heat per pound of gas is less than that of the exhaust, hence much greater heating surface is required per degree rise in temperature in a gas heater than in an exhaust heater. It is impracticable to design either a smoke box or exhaust heater to preheat water from the tank to boiler temperature, but ample space is afforded in the front end of the modern locomotive, in addition to the space required for superheater units, to build a gas heater of sufficient heating surface to obtain a high degree of preheat, feeding by means of the injector, the preheat increasing with the velocity and temperature of the gases.

As the final temperature of the feed water from the exhaust heater is limited to a point below that of the temperature of the exhaust steam, the smoke box heater presents greater possibilities when injector feeding is practiced, particularly when certain types of injectors are used which deliver the water at a higher temperature than that of the exhaust steam, from and above which point the smoke box heater may carry on the heating process up to the limits of the heat transfer rate for that particular design of heater and conditions of operation.

After utilizing all of the exhaust steam possible in preheating, there is still a margin of 140 deg. to 180 deg. between the feed temperature and that of the water in the boiler; and to bring these temperatures closer together we

have only the waste gases to fall back upon, hence with initial temperatures lower than that of the exhaust steam the advisability of using exhaust steam and smoke box heater in connection is clearly evident.

The practical limit of preheating feed water by means of smoke box gases is that of the boiling point, which at 200 lb. pressure is 388 deg. F. If a front end heater is used independently and not in combination with an exhaust steam heater, assuming an initial feed water temperature of 160 deg., the feed water offers the possibility of absorbing 228 B. t. u. per pound. If we assume an evaporation of 7 lb. of water per pound of coal, there will be offered an opportunity of absorbing, roughly, 1,596 B. t. u. per pound of coal, or approximately 50 per cent of the heat of the gases passing out through the stack. This requires a greater heating surface than is obtainable in the ordinary smoke box, due to space limitations. It is apparent that the higher the percentage of the available B. t. u. in the gases absorbed by the preheater, the greater is the efficiency.



A, B, D, E and F are cast steel headers.
C and G are 2-in. steel tubes beaded and welded to the headers.

H and K connect with the branch pipe from the left injector.
M and N connect with the boiler check.

Fig. 4—Smoke Box Feed Water Heater

TYPES OF LOCOMOTIVE FEED WATER HEATERS

Locomotive feed water heaters may be classified in three types, with varied design and structural detail which will not be dwelt upon in this report. These types are as follows:

(*a*) Waste gas type.
(*b*) Exhaust steam or surface condenser type.
(*c*) Exhaust or open heater type.

Smoke Box Heaters—Type A.—A smoke box gas heater was developed for the purpose of experiment by this Association in connection with the discussion of this subject at the 1914 meeting.* It is essentially a water line smoke box and diaphragm. A modification of this type heater is being developed as shown in Fig. 4, the shell and flat plates of the diaphragm being supplanted by a series or system of tubes terminating in the manifold headers contained within the smoke box, providing a continuous circuit from header to header in a circumferential direction around the inside of the smoke box. This section of the heater is connected to a supplementary unit conforming to the baffle and table plate, which are not removed. This unit consists of two headers connected by means of curved tubes, so arranged and connected as to allow a circulation of water through the supplementary header *D* into tubes *G*, into header *E*, thence into the boiler. This modification increases the heating surface and permits accessibility and easy cleaning of all parts. In some respects this arrangement is similar to that developed by F. F. Gaines, superintendent of motive power, Central of Georgia Railway. Smoke box heaters of this type are being constructed for test by the committee, both for road service and in the railway testing plant of the University of Illinois, the results of which tests among others will be available for publication in a subsequent report.

Auxiliary Heater—Type B.—An exhaust steam preheater is contemplated as an auxiliary unit in connection with the front end heater, as in a former series of heater tests,* this unit being illustrated in Fig. 5, and is designed for application to the boiler feed line between the injector or pump and the smoke box heater, placed under the running board on either side or both. The water to be heated is admitted into compartment 2 of header *A*. Exhaust steam from the exhaust passages of the cylinder and from the air or feed pump is admitted at openings 3 and 4, passing around the tubes.

Exhaust Steam Heater—Type B.—Of Type B one of the most efficient exhaust steam heaters is illustrated in Fig. 6. This is an independent unit, fed by a pump of special design. This construction is known as a spirally corrugated film type heater. It consists of two spirally corrugated copper tubes, one placed within the other, so as to leave a space 3/16-in. wide between the two tubes. The water to be heated passes between the tubes in the form of a thin film, and the exhaust steam that is being condensed reaches the outer surface of the outer tube and the inner surface of the inner tube, thus placing the film between the two heating surfaces. A new type of heater is being developed along these lines by the same engineers, which will permit the condensing of the same quantity of steam with less frictional resistance through the heater.

* Paper by Munro B. Lanier—1914 Proceedings.

Open Heaters—Type C.—Open heaters with direct condensation of the steam into the water is probably the first development of the system of preheating. Direct condensation may be handled in two ways: First by an exhaust steam injector, which not only acts as a heater but also pumps the water; and second, by injection of the steam into the water in a heater, and then pumping it into the boiler. The most common practice is to discharge the exhaust from the pump into the tank, where a maximum temperature of 104 deg. F. may be limited by a thermostatic valve.

AGITATION AND CONVECTION

Velocity of water flow is a material factor in preheating. Very extensive experiments that have been made with different forms of apparatus have proved that the heat transfer through a metal tube from steam to water varies with the

Fig. 5—Exhaust Steam Heater—Type B

amount of agitation of the water within the tube, particularly the scouring action of the water against the tube. In other words, there seems to be no difficulty in getting the heat through the metal, and the problem is to get it into the water. The faster each particle of water is brought into close contact with the tube and taken away again to give room for the next particle, the faster will be the heat transfer through each unit area of the tube.

HEAT TRANSFER

The heat transfer rate from smoke box gases to water seems to follow the same general laws as govern the transfer from the gases in boiler tubes to water.

AXIOMS OF PREHEATER CONSTRUCTION

Six principles for feed water heating of all types, most of which have been confirmed by separate boards of engi-

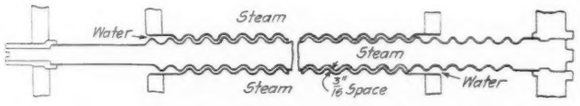


Fig. 6—A Unit of An Exhaust Steam Heater

neers in France and England, cover the essential features very closely. These are as follows:

1. The apparatus should present simplicity of construction and facilitate examination, cleaning and overhauling.
2. The heater should take up as little room as possible, and be of a minimum weight.
3. It should give continuous and certain supply of hot water.
4. Feed water should be heated by steam or gas, otherwise lost.
5. The steam used for heating should vary with the quantity of water required by the boiler.
6. Smoke box heaters should be placed within the path of the hot gases, presenting the smallest gas passage section practicable without detriment to draft.

BOILER FEEDING

It is advisable beyond question to use a water pump in connection with exhaust steam water heaters for the following reasons, assuming that a satisfactory pump may be developed for the rough usage of locomotive practice: It has been clearly shown that the amount of waste heat that can be abstracted from the exhaust is dependent entirely upon the range over which the water can be heated. The upper point of this range is fixed by the temperature of the exhaust steam, which naturally cannot be exceeded, and therefore the inlet temperature should be as low as possible in order to get the widest range of temperature change and reclaim the largest amount of waste heat that is feasible. The inlet temperature cannot be below the temperature of the water in the tank, but it should not be above this. Therefore it is undesirable to raise the temperature by live steam, as would be the case if an injector were used before it enters the heater. For instance, take the case mentioned above, where the injector raised the temperature of the feed water over 100 deg. by means of live steam—this would simply mean the impossibility of abstracting over 100 B. t. u. from the exhaust steam for each pound of feed water which could otherwise be reclaimed. With hot gas preheaters this does not apply, as the heat available from this source may be absorbed in addition to that heat supplied through the injector.

LOCOMOTIVE FEED WATER PUMPS

There are two kinds of pumps available for this service, one being a modification of the old style cross-head pump, which is simply a water cylinder, the piston of which is operated by direct connection to the running gear of the locomotive. The other is an ordinary steam driven water pump, of which there are a large number on the market.

Westinghouse Vertical Water Pump.—A water pump has been designed especially for locomotive use by the Westinghouse Air Brake Company. A steam cylinder of a 9½-in. air pump is the propelling mechanism. Below this is the water cylinder, which is 6½ in. diameter and is capable of handling up to 88,000 lb. of water an hour. On either side of the water cylinder are large valve chambers, in which the valves are located in removable plates in a very convenient and accessible manner.

This pump is generally supported on the side of the boiler in the same maner as an air pump, and its operation is controlled by a simple type of throttle valve located in the cab. The pump has shown itself to be very efficient and is capable of handling over 50 lb. of water against a pressure of 240 lb. for each pound of steam at a pressure of 165 lb.

There have been several attempts made to heat the water before it goes to the pump. These attempts have been universally unsatisfactory, and it is very important for maximum efficiency and reliable service that the pump handle cold water only.

CONCLUSION

Preheat is a fundamental necessity, easily within our grasp, which can no longer be overlooked. The failure of American railways to utilize preheat is an economic mistake which may be expressed in terms of millions of dollars of lost earnings to them.

The report is signed by: Munro B. Lanier, chairman; Prof. E. C. Schmidt, G. M. Basford, A. B. Appler, L. G. Plant, J. L. Hampson, O. C. Wright, and F. Kerby.

DISCUSSION

There have been numerous trials of feed water heaters extending over a period of many years. Difficulties experienced with the apparatus have always led to its abandonment. The question of maintenance is therefore of extreme importance and in designs which are now being tested this feature has been given special consideration. In exhaust steam heaters the speed at which the water travels gives a high rate of heat transfer by reason of the scouring action and is also effective in keeping the surfaces clean. The introduction of feed water heating gives promise of further increasing the thermal efficiency of the locomotive which has been brought from 3½ to 8 per cent by various improvements in the last two decades.

MIKADO TYPE LOCOMOTIVE TESTS

Pennsylvania Test Plant Results Obtained With Mikado and Consolidation Locomotives Compared

IN a previous article* there were given the results of tests on the testing plant of the Pennsylvania Railroad at Altoona, Pa., of a class E6s Atlantic type locomotive. The present discussion is based on Testing Plant Bulletin No. 28 (copyright, 1915, by the Pennsylvania Railroad Company) which deals with the tests of a class L1s locomotive.

For a long time the Consolidation (2-8-0) type was in general use for freight service on the Pennsylvania; but the requirements of heavier freight trains made greater locomotive capacity desirable, and as larger boiler capacity was essential to obtain this, the Mikado (2-8-2) type was resorted to. This locomotive was described in the *Railway Mechanical Engineer*, July, 1914, page 343. The same refinement of design is present in this locomotive and in the class K4s Pacific type, as exists in the class E6s Atlantics.

The Consolidation locomotives in general use on the Pennsylvania for the heaviest freight service up to the time that the Mikado type was introduced were the H9s class. The following table gives the principal data for the two classes, and the results obtained in the test of the Mikado are compared throughout with the results of similar tests of one of the Consolidations. Both are simple engines and are equipped with superheaters and brick arches.

Using 80 per cent of the boiler pressure, the calculated maximum tractive effort of the Mikado is 57,850 lb., and the factor of adhesion is 4.08. The calculated drawbar pull is equivalent to 352.7 lb. drawbar pull per lb. of mean effective pressure.

It is worthy of note that with an increase over the Consolidation of 25.7 per cent in total weight, and of 25 per cent in tractive effort (the maximum calculated tractive effort of the Consolidation is 46,300 lb.), there is but 7.2 per cent increase in the weight on drivers, showing that a good weight distribution has been obtained.

Railway Mechanical Engineer, April, 1917, page 171.

The boiler of the Mikado is interchangeable with that of the class K4s Pacific type locomotive, tests of which will be dealt with in a later article. The proportions of the boiler were carefully considered and the firebox portion forms almost one-half the entire length, while the tubes, which are of 2¼ in. diameter, are but 19 ft. long, the ratio of length to inside diameter being 114. An internal projection exhaust nozzle, with an area equivalent to a circular nozzle 7 in. in diameter, is used with an inside extension stack 5 ft. 10 in. long, tapering from 24 in. in diameter inside at the top to 17 in. at the point where it bells out at the bottom. The bottom of the stack is 13½ in. above the top of the exhaust nozzle.

	Mikado Class L1s	Consolidation Class H9s
Weight in working order, total lb.	320,700	251,050
Weight on drivers, working order, lb.	240,200	223,400
Cylinders, diameter and stroke, in.	27 x 30	25 x 28
Driving wheels, diameter, in.	62	62
Heating surface, tubes (water side), sq. ft.	3,715.7	2,480.2
Heating surface, firebox (including arch tubes), sq. ft.	301.5	189.9
Heating surface, superheater (fire side), sq. ft.	1,171.6	809.0
Heating surface, total (based on water side of tubes), including superheater, sq. ft.	5,188.8	3,829.1
Heating surface, total (based on fire side of tubes), including superheater, sq. ft.	4,847.7	3,536.5
Grate area, sq. ft.	70.0	55.3
Boiler pressure, lb. per sq. in.	205	205
Valves	12 in. piston	12 in. piston
Valve motion	Walschaert	Walschaert
Firebox	Wide, Belpaire	Wide, Belpaire
Tubes, number and outside diameter	237—2¼ in.	265—2 in.
Superheater flues, number and outside diameter	40—5½ in.	36—5¾ in.
Tubes and flues, length, in.	226.51	180.19

The tests were all run with a wide open throttle, the speeds ranging from 7.2 to 31.1 miles an hour, with cut-offs from 20 to 80 per cent of the stroke. The coal used was run of mine, as used in freight service on the Pennsylvania, with a heating value between 13,600 and 14,300 B. t. u. per lb.

An analysis of an average sample shows fixed carbon, 58.02 per cent; volatile matter, 31.59 per cent; moisture 1.20 per cent, and ash 9.19 per cent, with sulphur, separately determined, 1.44 per cent. The B. t. u. per lb. of dry coal are 14,140 and per lb. of combustible 15,590.

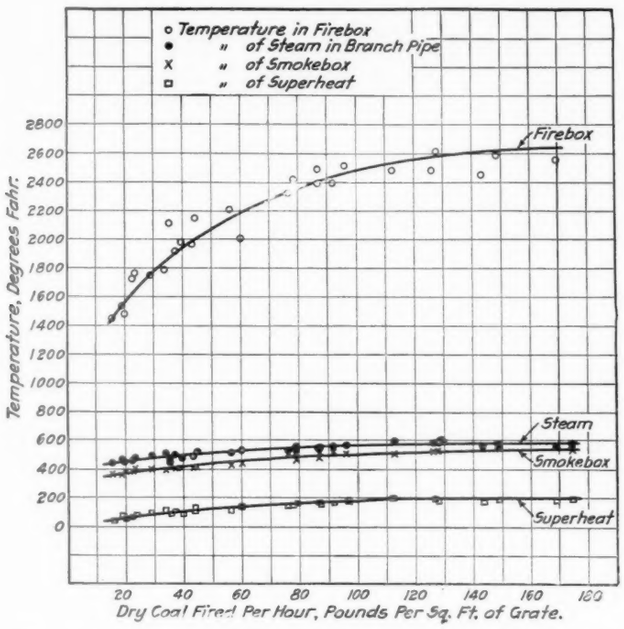


Fig. 1—Steam Temperatures and Temperatures in the Firebox and Smokebox

BOILER PERFORMANCE

The maximum steam temperature obtained was 590.6 deg., the superheat then being 207 deg. The temperature taken in the exhaust passage showed superheat in most cases, the maximum being 85.4 deg. The firebox and smokebox temperatures are shown in Fig. 1. It will be noted that, as a rule, the smokebox temperatures are below 550 deg., indicating the efficiency of the heating surfaces. The firebox temperatures above 2,400 deg., for rates of firing above 85 lb. per sq. ft. of grate per hour, are unusually high and the whole range of firebox temperatures is greater than is usual. Combustion was remarkably good and carbon monoxide in the smokebox gases did not exceed 0.5 per cent under any conditions. These tests showed rates of evaporation never before obtained on the test plant. The draft is shown in Figs. 2 and 3 in relation to the rate of combustion and the evaporation per square foot of heating surface. The ashpan air openings are inadequate, totaling 7.8 sq. ft. which is 11 per cent of the grate area. It has been found that this ratio should not be less than 15 per cent. The draft in the ashpan under maximum firing conditions, about one inch of water, is high.

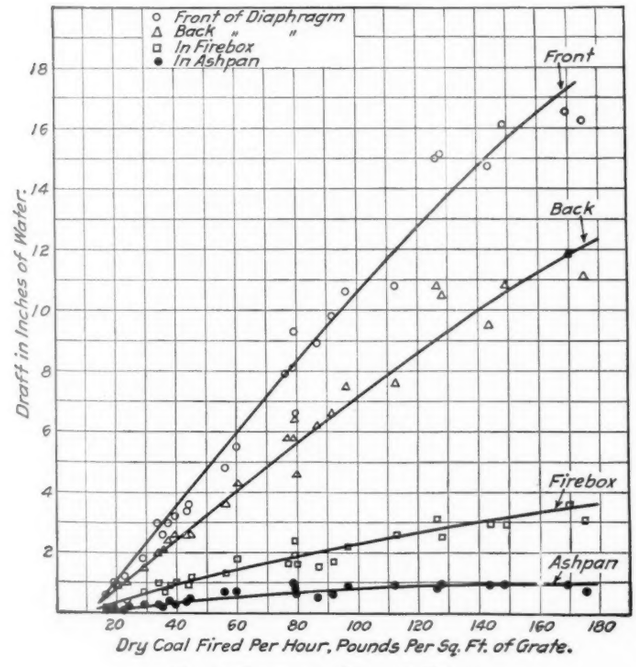


Fig. 2—Draft and Rate of Firing

From comparisons with tests of seven locomotives on the testing plant it is apparent that maximum evaporation is closely related to the fire area or the area of all the tube openings. These seven locomotives indicate that under normal conditions each square foot of fire area of the tubes will give a maximum evaporation of about 7,000 lb. of water per hour. Quoting direct from the bulletin: "Considering further the proportions of these boilers, we have in the following table certain ratios and the maximum evaporation that it was possible to obtain on the test plant:

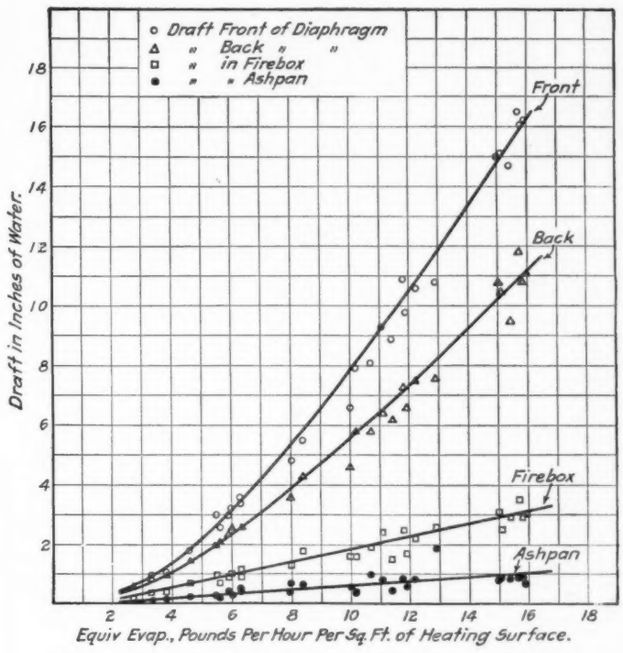


Fig. 3—Relation of Draft to the Rate of Evaporation

Class of locomotive	Ratios: Heating surface to grate	Fire area to grate	Firebox heating surface to grate	Tube heating surface to firebox heating surface	Firebox volume to grate surface	Maximum evaporation per hour per square foot of heating surface	Corresponding rate of combustion, pounds per square foot of grate
	1	2	3	4	5	6	7
D16sb (8-wheel)	47.7	0.12	5.3	6.2	4.6	18.6	197
E3sd, Atlantic	43.5	0.09	3.3	9.2	3.7	14.5	104
K4s, Pacific	70.2	0.12	4.4	11.0	6.2	13.5	171
E6s, Atlantic	61.2	0.12	4.2	10.2	6.2	13.1	148
L1s, Mikado	70.2	0.12	4.4	11.0	6.1	12.8	163
H9s-1311, Cons.	64.2	0.13	3.5	13.0	3.6	11.6	132
K2sa, Pacific	80.3	0.14	3.9	15.0	4.6	10.9	147
K29s, Pacific	77.8	0.13	3.3	17.0	4.4	9.8	120
H9s-387, Cons.	63.9	0.13	3.4	13.4	3.6	9.6	93

"The ratio of tube to firebox heating surfaces (column 4) shows a range of values between 6 and 17, and in Fig. 4

this ratio and the maximum evaporation per sq. ft. of total heating surface have been plotted. The H9s-387 has a low maximum evaporation while the evaporation of the H9s-1311, as developed in a second series of tests, shows a normal rate as compared with the other locomotives of this group, all of which have superheaters.

"A maximum evaporation of 38,800 lb. of water per hour was obtained with the improved H9s and this is 11 lb. per sq. ft. of heating surface, or 5,308 lb. per sq. ft. of fire area of tubes. This increased rate of evaporation is still comparatively low, but considering the small firebox heating

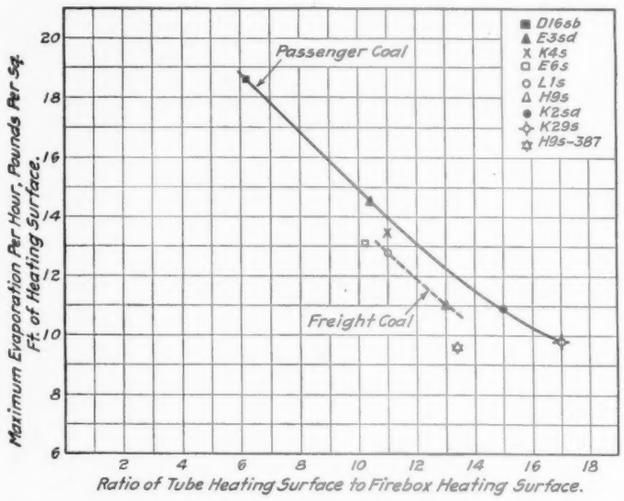


Fig. 4—Rate of Evaporation as Effected by Heating Surface Distribution

surface of the H9s where the ratio of tube heating surface to firebox heating surface is 13, while for the L1s it is 11, or in the L1s the firebox forms a larger proportion of the whole boiler than in the H9s, it is evident that the H9s cannot show as great an evaporation per unit of heating surface as the L1s, and for its firebox heating surface it evaporates about all that may be expected of the design."

It is evident from the exhibits in Fig. 4, that a relatively

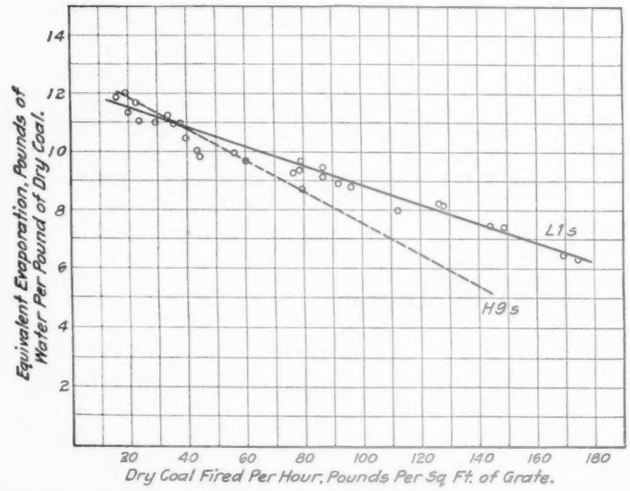


Fig. 5—Relation of Equivalent Evaporation Per Pound of Dry Coal to the Firing Rate

large firebox heating surface makes possible a high rate of evaporation per unit of total heating surface.

The advantage of the larger boiler is evident when comparison is made of the coal fired and water evaporated. The Consolidation reaches its maximum evaporation at 34,000 lb. per hour, the coal consumption rate being 8,000 lb. per hour; while the Mikado did not reach its evaporative limit till about 60,000 lb. of water were being evaporated per hour, with a coal rate of 12,000 lb.

Equivalent evaporation per lb. of dry coal is shown in

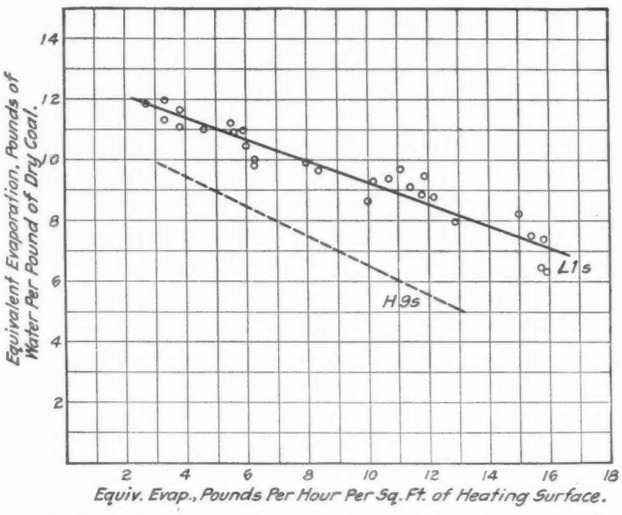

Equivalent Evaporation, Pounds of Water Per Pound of Dry Coal.
Equiv. Evap., Pounds Per Hour Per Sq. Ft. of Heating Surface.
L1s
H9s

Fig. 6—Equivalent Evaporation Per Pound of Dry Coal in Relation to Rate of Evaporation

Figs. 5 and 6. The results for the Consolidation, it will be seen, are considerably below those for the Mikado, which had a range of firing between 20 and 180 lb. of coal per sq ft. of grate per hour, and at the highest rate of firing the water evaporated per lb. of coal is above 6 lb. On a basis of heating surface, the Mikado shows a range of evapora-

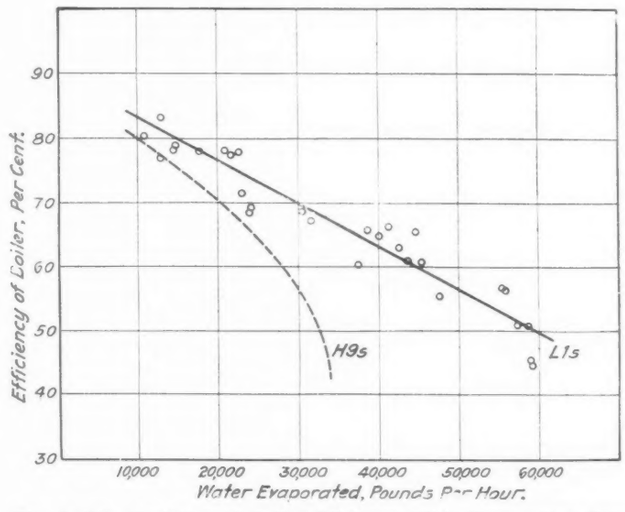


Fig. 7—The Variation of Boiler Efficiency With Evaporation Rate

tion between 3 and 16 lb. of water per sq. ft. of heating surface.

The boiler efficiency is shown by Fig. 7. The boiler horsepower at 34.5 lb. of water per horsepower hour from a feed water temperature of 212 deg. into steam at a temperature of 212 deg., ranged between 382 and 2,232. The efficiency of the boiler was between 80 and 45 per cent. It will be noted from the diagram how rapidly the efficiency of the Consolidation's boiler falls off, compared with that of the Mikado, at rates of evaporation above 25,000 lb. per hour. The Consolidation also showed a lower efficiency at all rates

of firing above 30 lb. per sq. ft. of grate per hour. For the Mikado, the firing rate was between 20 and 175 lb. per sq. ft. of grate, the efficiency of the boiler, as previously stated, ranging between 80 and 45 per cent.

ENGINE PERFORMANCE

The indicated horsepower of the Mikado covered a range between 356 with 20 per cent cut-off at a speed of 7.2 miles

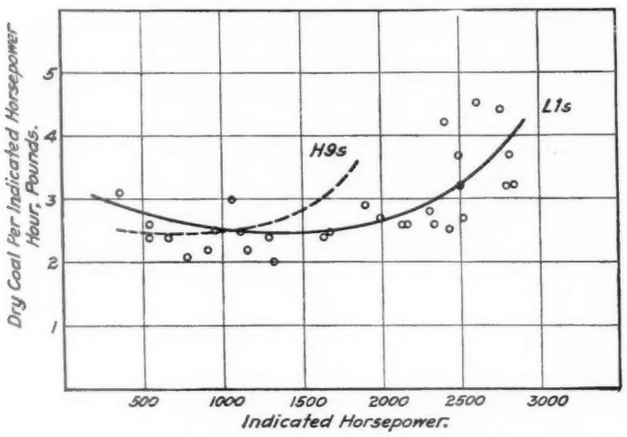


Fig. 8—Coal per Horsepower Hour and Indicated Horsepower

per hour, and 2,837 at 60 per cent cut-off and a speed of 31.1 miles per hour. The coal rate varied between about 2.5 lb. and 4 lb., the greatest economy being at about 1,500 i. hp., where the coal rate is 2.5 lb. per hp. hour. The coal per horsepower is shown in Fig. 8 and the water rate in Fig. 9. The best steam performance of the Mikado is at a rate of working of about 2,000 i. hp. The greater economy of the Consolidation is probably due to the higher degree of superheat obtained. The steam rate of the Mikado varies between 19 lb. and 24 lb. The maximum horsepower obtained from the Mikado, 2,837.2, is greater than that obtained from any other freight locomotive ever tested on this plant, the maxi-

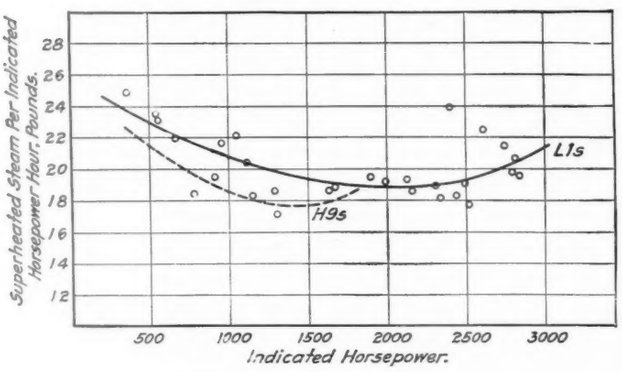


Fig. 9—Water Rate and Indicated Horsepower

mum horsepower of the H9s class having been found to be about 2,100. On the basis of pounds of dry coal fired per hour, the indicated horsepower of the two locomotives is shown in Fig. 10.

In the matter of back pressure, the Mikado shows a minimum of less than one pound and a maximum of 16 lb. At the maximum horsepower of the Consolidation, which was 1,800 in these tests, the back pressure is 8 lb., while the Mikado shows but 4 lb. at the same power. The larger exhaust nozzle of the Mikado, 38.3 sq. in. as against 30.9 sq. in. for the Consolidation, probably has an important bearing on this result.

The Mikado, which has larger cylinders than the Consolidation shows a corresponding increase in horsepower at cut-offs beyond about 40 per cent.

The engines of the Mikado use from 18,500 to 26,100 B. t. u. per i. hp. hour and convert into work from 9.7 to 13.7 per cent of the heat supplied. In plotting the thermal efficiency of the engines it is again found that they are the most efficient when developing about 2,000 i. hp.

DYNAMOMETER RECORD

The dynamometer horsepowers reached are as high as 2,563, the dry coal fired per d. hp. hour ranging between 2.7

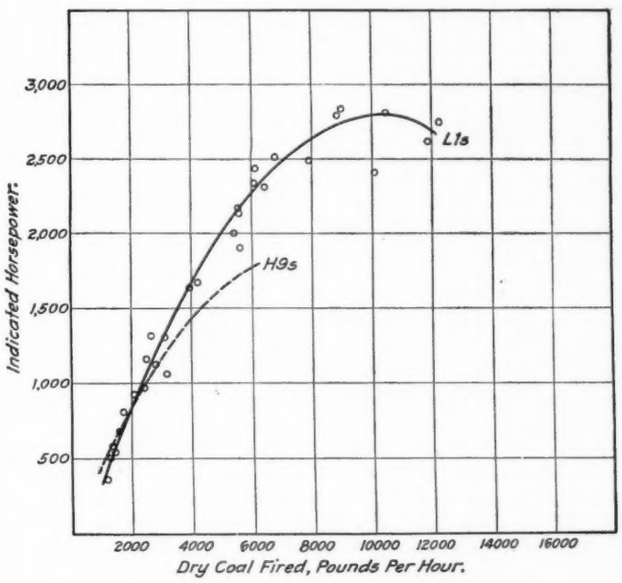


Fig. 10—Relation of Coal Fired to Indicated Horsepower

and 4.8 lb., while the consumption of superheated steam was between 20.1 and 34.6 lb. per d. hp. hour. The thermal efficiency of the locomotive reached 7 per cent. In tests of an hour or more, the drawbar pull ranged between 6,455 lb. at a speed of 170 r. p. m., or 31 miles per hour, with a cut-

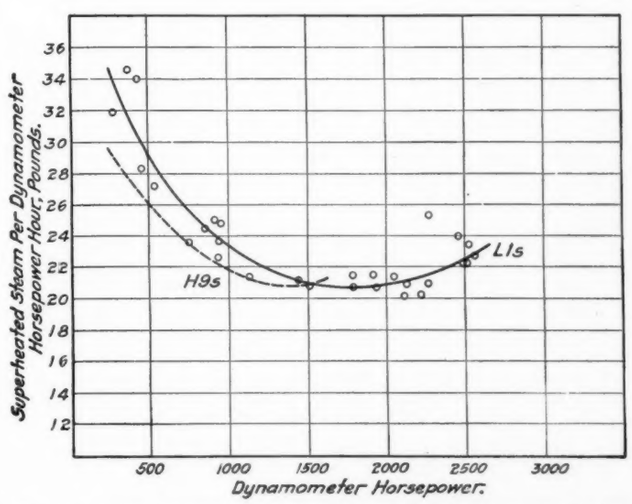


Fig. 11.—Steam Consumption per Dynamometer Horsepower Hour.

off of 20 per cent, and 48,962 lb. at 40 r.p.m., or 7.2 m.p.h., and 60 per cent cut-off. Higher pulls were obtained in shorter tests, and the Mikado was shown to be capable of developing a pull of 59,000 lb. up to a speed of 7 m.p.h.,

48,600 lb. at 18 m. p. h. and 32,200 lb. at 30 m. p. h. With the Consolidation, 50,000 lb. was obtained at 7 m.p.h., 33,000 lb. at 18 m. p. h., and 20,000 lb. at 30 m. p. h., showing the advantage of the Mikado over the Consolidation for all classes of freight service.

The steam consumption on the basis of dynamometer horsepower is shown in Fig. 11, while Fig. 12 shows the

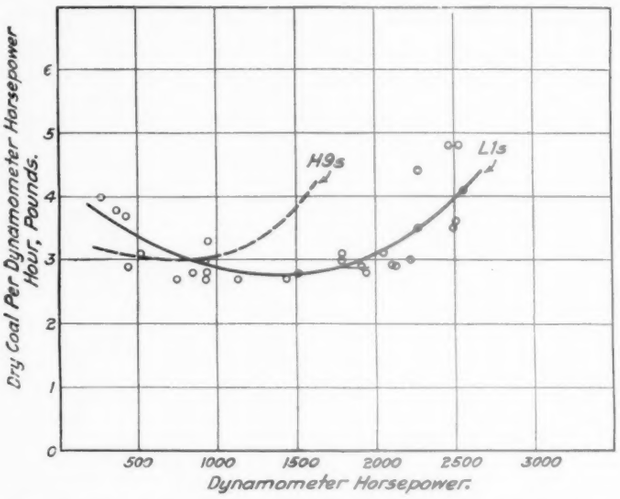


Fig. 12—Coal Consumption per Dynamometer Horsepower Hour

coal consumption. The water rate for the Mikado is comparatively high at horsepowers below 1,500, the best performance being at about 1,800 d. hp. where the steam rate is 20.5 lb. The Mikado shows its best coal performance at about 1,400 d. hp., the rate being 2.75 lb. per hp. hour.

It is possible to operate the Mikado throughout the speed range of the tests at cut-offs between 25 and 60 per cent of

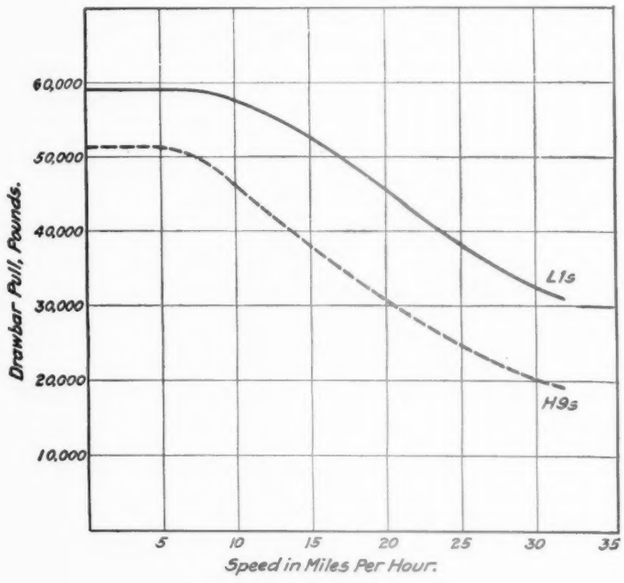


Fig. 13—Drawbar Pull Curves

the stroke, and still not exceed its boiler capacity. On one test, at 18 miles an hour, the boiler furnished steam for a cut-off of 80 per cent. To obtain the highest drawbar pull and at the same time its best efficiency, the locomotive must have a wide open throttle and at speeds below 30 miles an hour the cut-off should be greater than 60 per cent.

The machine efficiency for the Mikado ranged between 64.8 and 94.5 per cent and for the Consolidation between 69.3 and 93.8 per cent. It will be seen that the two locomotives give similar results in this respect, notwithstanding the greater weight on the drivers of the Mikado. The machine efficiency increased up to 18 m.p.h., then decreased as the speed increased to 32 m.p.h. The thermal efficiency showed a tendency to increase with the speed up to 22 m.p.h., after which it gradually fell off. The range was from 3.9 to 7 per cent. The Mikado has some advantage over the Consolidation in thermal efficiency because of its larger boiler.

CONCLUSIONS

The satisfactory performance of the Mikado's boiler is indicated by its maximum evaporation per hour, 6,990 lb. of water per sq. ft. of fire area through the tubes. The design of the smoke stack and front end proved satisfactory, and with the changes in the superheater, the all-around performance of the locomotive was most gratifying, the high horsepower developed being particularly noteworthy. The locomotive was designed to give a capacity about 25 per cent greater than the H9s. The drawbar pulls obtained, however, indicate that it gives 25 per cent greater pulls at 10 m.p.h. and 60 per cent greater at 30 m.p.h. A large number of these locomotives are now in freight service on the Pennsylvania.

KINDLING FIRES IN LOCOMOTIVES*

BY H. B. BROWN
General Fuel Inspector, Illinois Central

In order that a comprehensive idea might be obtained as to the cost of kindling fires in locomotives, a circular letter was sent to the railroads, asking for information regarding the kind of fuel used in kindling fires at terminals, the grate area of the locomotives, the pounds of coal used, the water temperature, the labor cost and total cost. From the replies to this circular, the data shown in the table was compiled. The locomotives were separated into three different classes, one having a large, another a medium and the third a small grate area. In compiling the total cost, 63,000 locomotives were considered as being used on 250,000 miles of line, 10 per cent being deducted for the number in shops. The total number of locomotives was divided into the three classes by assuming that 20 per cent of the total have a

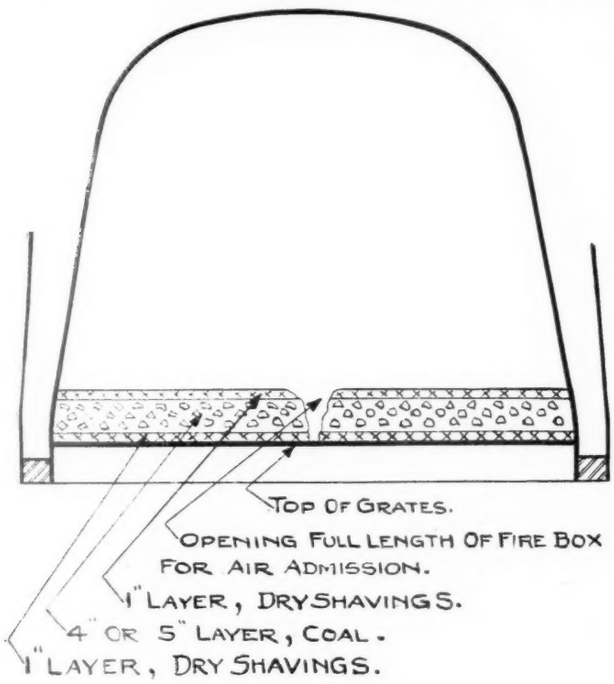
Comparative Cost of Firing Up Engines at Terminals.

Material Used for Firing.	Size of Grate Area.	Daily Cost.	Cost for Firing 50 Per Cent Each Class Engine Once a Day.	Yearly Savings for Firing Once a Day with Shavings.
Dry Shavings	Large	$1.14	$2,326,968.00	.....
	Medium	.95	4,847,850.00	.....
	Small	.68	2,082,024.00	.....
Oil Soaked Shavings	Large	2.04	4,164,048.00	$1,837,080.00
	Medium	1.41	7,195,230.00	2,347,380.00
	Small	1.08	3,306,744.00	1,224,720.00
				$5,409,180.00
Scraps, Car Shops	Large	$1.93	$3,939,516.00	$1,612,548.00
	Medium	2.08	10,614,240.00	5,766,390.00
	Small	1.40	4,286,520.00	2,204,496.00
				$9,583,434.00
Cord Wood	Large	$2.87	$5,858,244.00	$3,531,276.00
	Medium	1.19	6,072,570.00	1,224,720.00
	Small	.70	4,286,520.00	2,204,396,00
				$6,960,492.00
Oil Sprayed on Coal	Large	$1.62	$3,306,734.00	$398,034.00
	Medium	1.20	6,123,600.00	1,275,750.00
	Small	.82	2,510,676.00	428,652.00
				$2,102,436.00
Fuel Oil	Large	$2.35	$4,796,820.00	$2,469,852.00
	Medium	1.49	7,603,470.00	2,755,620.00
	Small	1.09	3,338,162.00	1,256,138.00
				$6,481,610.00
Live Coals	Large	$2.45	$5,000,940.00	$2,673,972.00
	Medium	1.40	7,141,680.00	2,293,830.00
	Small	1.10	3,367,980.00	1,285,956.00
				$6,253,758.00

* Abstract of a committee report presented at the 1917 Convention of the International Railway Fuel Association.

large grate area, that 50 per cent have a medium grate area and that 30 per cent have a small grate area.

It was found that kindling with dry shavings was the cheapest method and the costs of all the other methods were compared with this method. In the dry shaving method, a one-inch layer of dry shavings was placed on the grate first, then four or five inches of coal and another inch layer of dry shavings. An opening was left in the middle for the full length of the firebox for the admission of air to aid the combustion and to eliminate smoke. The second method of firing shown in the table was similar to the first with the exception that oil soaked shavings were used instead of the



Method of Building Fires with Dry Shavings

dry shavings. The third method refers to a fuel bed made up of a 5-in. layer of scrap wood taken from the car shops, laid directly on top of the grate with a 5-in. layer of coal, an opening being left in the middle of the firebox for the full length for the admission of air. The fourth method relates to the use of a 5-in. layer of cord wood and a 5-in. layer of coal, similar to the third method. The fifth method relates to a 5-in. layer of coal with oil spread on top, an opening being left for the full length of the firebox in the middle of the fuel bed. In kindling fires in locomotives burning fuel oil, the method followed was to use a piece of oil-soaked waste placed on top of the arch. The last method shown in the table relates to the use of live coal for the kindling of the fire.

It was found that a large amount of coal will be saved by placing a layer of shavings on the grate first, as it naturally prevents the coal from falling through the grate bars, becoming ignited in the ash pan and causing its deterioration. The reports show that as high as 80 lb. of coal was lost in this way and where the shavings were placed on top of the grate first, this amount was reduced to six pounds.

DISCUSSION

The cost of kindling fires is not generally realized and the work is seldom done in a systematic manner, due to the employment of cheap labor. Shop scrap and old ties can sometimes be used and are economical and satisfactory. The supply of shavings is often insufficient to meet the requirements. Air jets introduced into the firebox to eliminate smoke have given good results.

PHILADELPHIA & READING MALLET LOCOMOTIVES

The Philadelphia & Reading has recently received from the Baldwin Locomotive Works six Mallet locomotives of the 2-8-8-2 type, which develop a tractive effort of 98,400 lb. They are used on the Frackville hill near Pottsville, Pa., which has a ruling grade of 3.3 per cent and curves of 16 deg. The service consists chiefly in hauling empty coal cars up the grade and bringing loads down. They are hauling trains of 38 to 48 cars up the grade with ease, the tonnage being about 43 per cent heavier than that previously handled by the heavy Mikado type locomotives which they have replaced. The Mallet type locomotives are also proving to be easier on the track than were the Mikados.

These locomotives are of special interest because of the restricted clearance limits imposed. The height limit is 15 ft. and the width limit over the low pressure cylinders is 11 ft., while the width over the running boards does not exceed 10 ft. 8 in. The boiler center is placed 9 ft. 9 in. above the rail, and this comparatively low elevation increased the difficulty of working out some of the details of the design.

The boiler is of the Wootten type, which is standard on the Philadelphia & Reading. It is one of the largest Wootten boilers thus far built, having a diameter at the throat of 102 in. and a grate area of 108 sq. ft. It is designed for a pressure of 225 lb., but in service the safety valves are set at 210 lb. The total equivalent heating surface is 7,901 sq. ft. The design incorporates a combustion chamber 46 in. long, across the throat of which is built a brick wall 26 in. high. In flanging the firebox sheets and the back head it was possible to use the same dies which were used for the Mikado type locomotives previously built by the Baldwin Locomotive Works for the same road.

The fire door is single and has a width of 35 in. It is fitted with a Franklin fire door. The grates, which are arranged to shake in five sections, are operated by a Franklin grate shaker. The grate is divided into three sections by two longitudinal bearers. Each side section is operated in three groups; in the center section there are drop plates at the front and back, the bars between the plates being connected in two groups. The ashpan has three hoppers, two of which are placed outside the frames between the rear driving wheels and the trailing truck.

The locomotives are fired by Street type "C" stokers, which are handling a 50 per cent mixture of anthracite buckwheat and bituminous coal very satisfactorily.

The throttle is of the Rushton type, with auxiliary drifting valve. The throttle lever is placed in a vertical position on the right hand side of the cab and is connected to the throttle stem through a transverse rotating shaft. Piston valves 14 in. in diameter control the steam distribution to all the cylinders, and the valve gears are of the Walschaert type. The front and back reverse shafts are supported on the guide bearers and are bent to clear the boiler. A single reach rod, placed on the center line of the locomotive, connects the front and back reverse shafts. This arrangement, which is regularly used on Baldwin Mallet locomotives, occupies but little room and is particularly convenient on an engine where the clearance is restricted as it is in this case.

The high pressure pistons are of box form, while the low pressure pistons have cast steel dished centers with cast iron bull rings bolted on. The bull rings are widened at the bottom to give ample bearing area and no extension rods are used.

The forward frames are stopped just ahead of the leading driving pedestals and are bolted and keyed to a large steel casting which supports the low pressure cylinders. The forward equalizing beam is fulcrumed underneath this casting. The forward equalization system divides between the second and third pairs of driving wheels. As there is no

room to place springs over the boxes of the first and second pairs of wheels, beams are mounted over these boxes and the frames are supported on inverted leaf springs suspended from the beams. The forward central equalizer is connected to the beams over the front boxes through a transverse semi-elliptic spring, this arrangement having been adopted in lieu of using springs over the front driving boxes.

The radius bar connecting the front and rear frames is attached to a horizontal pin secured to the front frames and has a ball-jointed connection with the hinge pin. This arrangement, which is covered by a patent, has been applied by the builders to a number of recent articulated locomotives. In the Reading engines the frames are not interlocked in any way, so that the articulated joint has maximum flexibility in both a horizontal and vertical direction.

There are four sand boxes, two for the front group of wheels and two for the back group. The boxes are placed right and left on the round of the boiler, and the bell is similarly located on the right hand side. Front bumper steps are provided instead of a pilot, and the equipment in this respect is in accordance with the requirements for switching service.

The detail parts of these locomotives were designed to interchange where practicable with those of the Mikado type engines now in service on the Reading. The principal dimensions and ratios are given in the table:

General Data

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Anth. and bit. mixed
Tractive effort	98,400 lb.
Weight in working order	478,500 lb.
Weight on drivers	435,200 lb.
Weight on leading truck	23,000 lb.
Weight on trailing truck	20,300 lb.
Weight of engine and tender in working order (approx.)	630,000 lb.
Wheel base, driving	39 ft. 8 in.
Wheel base, total	55 ft. 10 in.
Wheel base, engine and tender	83 ft. 2½ in.

Ratios

Weight on drivers ÷ tractive effort	4.4
Total weight ÷ tractive effort	4.9
Tractive effort × diam. drivers ÷ equivalent heating surface*	691.2
Equivalent heating surface* ÷ grate area	73.2
Firebox heating surface ÷ equivalent heating surface,* per cent	4.5
Weight on drivers ÷ equivalent heating surface*	55.1
Total weight ÷ equivalent heating surface*	60.6
Volume equivalent simple cylinders	27.8 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	284.1
Grate area ÷ vol. cylinders	3.9

Cylinders

Kind	Compound
Diameter and stroke	26 in. and 40 in. by 32 in.

Valves

Kind	Piston
Diameter	14 in.

Wheels

Driving, diameter over tires	55½ in.
Driving, thickness of tires	3¼ in.
Driving journals, main, diameter and length	11 in. by 13 in.
Driving journals, others, diameter and length	11 in. by 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	7 in. by 11 in.
Trailing truck wheels, diameter	33 in.
Trailing truck, journals	7 in. by 11 in.

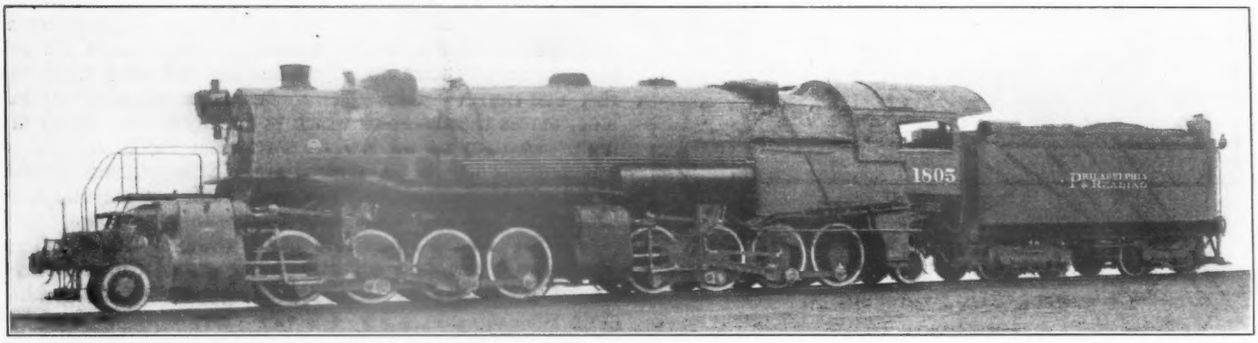
Boiler

Style	Wootten, conical
Working pressure	210 lb. per sq. in.
Outside diameter of first ring	90 in.
Firebox, length and width	144¼ in. by 108¼ in.
Firebox plates, thickness	Side, back and crown, ⅜ in.; tube, ⅝ in.
Firebox, water space	Front, 5 in.; sides and back, 4 in.
Tubes, number and outside diameter	277—2¼ in.
Flues, number and outside diameter	50—5½ in.
Tubes and flues, length	23 ft.
Heating surface, tubes and flues	5,389 sq. ft.
Heating surface, firebox†	358 sq. ft.
Heating surface, total	5,747 sq. ft.
Superheater heating surface	1,436 sq. ft.
Equivalent heating surface*	7,901 sq. ft.
Grate area	108 sq. ft.

Tender

Tank	Water bottom
Wheels, diameter	36 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	8,000 gal.
Coal capacity	13 tons

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.
† Includes combustion chamber heating surface.



Mallet Type Locomotive for the Philadelphia & Reading

GOOD FIRING

The Baltimore & Ohio, which has for a number of years conducted a strong campaign of education in the matter of firing locomotives, has recently published a text book for its engineers and firemen on good firing. This book contains instructions as to the proper methods of firing, prevention of smoke and the manner in which the various appliances pertaining to the burning of the fuel should be handled. A brief chapter on the elements in the theory of combustion is also contained in the book and presented in such a manner as to be readily understood by the enginemen. In the back of the book are given sixteen "don'ts" which make for good firing. These are given below:

Don't slug.
Don't overload tenders.
Don't overfill scoops.
Don't shake grates or use the hook when it may be avoided.
Don't allow pops to open unnecessarily.
Don't permit a dirty deck or apron, allowing coal to rattle off.
Don't knock coal off by careless handling of tools.
Don't throw large lumps into the fire—crack them.
Don't use blower, except when necessary.
Don't permit fire to get too heavy and dirty.
Don't bring locomotive to terminal with a heavy fire.
Don't allow fire to die out in front of firebox, causing leaky flues.
Don't bank fires and leave doors open when descending grades or stopping.
Don't fire on green coal or any spot unless white.
Don't permit banks.
Don't leave firedoor open when engine is working hard.

This method of instruction which shows the fireman how he may use his fuel to the best advantage and the reasons why these methods should be followed, is a very good one. With the prospect of 50 per cent to 100 per cent increase in the price of fuel, every means should be taken to interest the engine crew in the economical use of fuel. The time and money taken to write and publish a book of this sort is well invested. Those roads that have not done this should give the matter serious consideration, as nothing should be left undone which will reduce fuel consumption, the cost of which is the largest single item in railroad operating expenses.

THE LUBRICATION OF FREIGHT CARS IN INTERCHANGE*

BY T. J. BURNS
Superintendent Rolling Stock, Michigan Central

The question of hot boxes, their cause, and their cure has been discussed at every railroad club, in the offices of executives, and in the car men's shanty from time immemorial, and we are apparently no nearer a solution of the difficulty than ever,—the hot box in its recurring epidemics is still the bugbear of the profession, so to speak. Are the car men of the country to continue their assaults on the hot box situation along the old line of attack, and rest satisfied that the best has been done that can be done when the mere mechanical processes of the problem have been worked out? Is there no other action to be taken, no policy of lubrication as distinguished from purely mechanical practice which can be introduced that will help us out of the trenches?

I have no intention of discussing methods of packing hot boxes, or in attempting to arrive at any new conclusions as to the best methods of performing the work in a way that leads to greater economy. These points have all been carefully canvassed and we all have our published instructions on lubrication which are undoubtedly quite sufficient. Any further discussion at this time along these particular lines, while no doubt interesting, will get us nowhere in particular.

What I would like to submit, however, is a proposition contemplating that, instead of handling the lubrication of the freight car equipment as it is now handled under the theory that foreign cars will be given the same attention as owned cars, lubrication be put squarely under the M. C. B. Rules of Interchange the same as any other repair. I would propose that Rule 1, the corner stone of the M. C. B. code, be radically changed. I think the time has come when this rule will have to be changed. In its old wording it specified that the receiving line shall provide the same care and attention as to packing and oiling that it gives its own equipment. This was a good theory in its day and in the infancy of car interchange perhaps it served its purpose. But with the tightening up of supervision and the development of lubrication economies some mistaken policies have crept in. I feel I am violating no confidences when I say that it has become a part of the disposition of the receiving line to use only such of its lubricating materials as is absolutely necessary to carry a car over its own rails. I fear we are all more or less tarred with the same stick. Why? Simply because of no compensation either in labor or material for work performed. The result is that the foreign car long off its own rails, running from pillar to post with only such spasmodic oiling as is absolutely necessary at the time, eventually develops a hot box and a new brass is necessary, or perhaps a change of wheels. In our passenger car service where we have the equipment in our own control we repack periodically, but on our freight equipment just because a car is out of our hands we leave it to its fate. Why is it not as necessary to repack freight equipment as passenger equipment? The freight car journal box and its contained parts, the journal, the waste, and the oil are not of another world, they are of the same physical nature and subject to the same physical laws. Obviously, if we are to expect anywhere near similar performance from the two branches of the service they must receive somewhere near similar treatment. The answer is easy; attend to the packing. The only way this ever will be done will be by inserting in the code a rule that will meet with the necessities of the situation, by putting a premium on the work, and by paying for goods delivered,—just as you have done in your repair schedules by inserting a price that makes it an inducement for a foreign line to help maintain your car and keep it in operation. In other words, institute a system of periodical repacking and reoiling of the freight equipment of the country at large, and by that I mean all the equipment both of railroad and private ownership.

Right here I may as well anticipate the private car owner who will surely rise up in protest. The private car lines who are doing their full duty are not aimed at. If they will do their repacking as they should and guarantee their work by the stencil on their cars, that is all that will be asked of them. The private car owner is surely concerned in the continuous and successful movement of his car equally with the handling line, and one of his cars cut out or delayed enroute is an economic loss in which he has to participate in the final analysis. I only ask that they agree that a fair compensation was due the railroad company that repacked their car and stencilled on the car the necessary data.

All that I have said about the private car owner applies with full force to many of our railroads, and in all fairness to the private car owner we will have to admit that many of them now recognize the importance to themselves of proper lubrication of their equipment, doing work at their own plants that some of the railroads might do well to imitate. There are, however, unfortunately, some private car owners who make no pretense whatever as to the care of journal boxes, and I have this moment distinctly in mind one plant I visited recently where the man in charge took credit unto himself that his expense along this line was nil, and the only oil or waste supply in the entire yard was in a barrel that was used as a receptacle for old packing from destroyed trucks—and here again I may interject that there are some railroads of the same nationality, roads that deliberately "unload" on the receiving lines.

No calling together for educational purposes of our car oilers, no lubrication experts traveling over our line, no posting of blue prints, no instructions to our men, no technical discussions as to journal weights, designs of packing hooks, viscosity of oil, etc., will get us any farther on the high road of broad efficiency in lubrication matters than we now are. If we are looking for further progress in these matters we will have to work away from the idea that unrestricted car movements can be properly cared for by a restricted policy of any kind.

The details of the scheme of periodical reoiling and re-

*A paper read before the Central Railway Club on May 11, 1917.

packing, it is not my purpose to outline in this paper. These matters can be more satisfactorily handled by a competent committee. In general, however, I would suggest that all boxes be repacked say once a year, date of repacking to be suitably stencilled on the body or trucks of the car, a rule covering the matter together with a proper charge and with suitable specifications as to methods to be followed, to be incorporated in the M. C. B. code in its proper place and, as mentioned earlier, the re-vamping of rule No. 1 to correspond.

I fully realize that my position in this matter will be attacked. However, I wish to start a campaign of publicity. I am confident that the day will come when a plan of this kind will go into effect, and it may come much sooner than any of us expect.

In the great transportation scheme of the United States why do we satisfy ourselves with a localized treatment of a problem that effects nation wide commerce? If our railroads were all subject to one general supervision how long would we be allowed, in handling our transcontinental traffic, to work under a lubrication plan that boasts of no system, is intermittent in its application, and inefficient in results? The problems that have to do with car supply, mileage, per diem, even M. C. B. repairs, have all been worked out or are being worked to a point that will measure up to the obligations of the carriers to the traffic of the country, and yet we car men sit supremely satisfied with our local, cramped system of lubrication. If we are unable to see the light ourselves I very much fear it will be pointed out to us.

Definitely and finally, what I have to propose is that the Central Railway Club take this matter under advisement, and whip the matter into shape in time to present it to the authorized committee of the M. C. B. Association for incorporation in its Rules of Interchange at the 1918 Convention.

WOODEN FRAMED FREIGHT EQUIPMENT CARS

BY M. D.

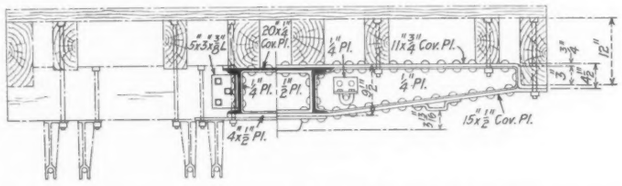
By reason of the present situation in the material market, most of the railroads are confronted both in the purchase of new rolling stock and in the repair and maintenance of existing freight equipment cars, with the problem of not being able to obtain rolled steel shapes, plates or castings in sufficient quantities to justify a suitable shopping program, apart from the fact that the expense involved presents a most serious problem.

Good judgment and a true knowledge of operating conditions must apply in the selection of an economical policy with regard to each separate class of car which is to be considered. In the reinforcement or rebuilding of cars having a rated capacity less than fifty tons, as much serious study is not required as that necessary on equipment of fifty-ton capacity, as in the past the average car of this capacity has not proven to be of equally good design as those having less rated capacity. A detailed study of the heavier equipment shows that in many cases the designers of this equipment have thought it necessary to provide only a truck of larger capacity and leave the body as it was, expecting it to withstand the more severe operating conditions to which it is subjected. This has been a great fault with this equipment and is responsible for a large number of failures with an undue increase in maintenance costs.

Wooden framed box cars having a capacity exceeding 40 tons are not generally considered desirable, because in order to provide reasonable cubical capacity for certain commodities, such as oats and cottonseed, it would give a very much unbalanced structure, the height or length of the car being excessive. Very few designs of wooden 50-ton coal cars have proven successful in heavy train service. However, it is possible to construct a 50-ton wooden gondola car so as to be reasonably free from failure, but experiments covering a period of several years have demonstrated the following necessary changes in design:

Description.	Original.	Final.
Area of wooden sills	441 sq. in.	425 sq. in.
Truck centers	30 ft.	28 ft.
Overhang	5 ft.	6 ft.
Diameter of truss rods	1¾ in.	1¼ in.
Number of truss rods	4	8
End sills	8 in. by 15½ in.	8 in. by 15 in. and 15 in., 40-lb. channel
Draft sills	Wooden	Cast steel draft arm or two 8-in. 16¼-lb. channels with a top cover plate 20 in. by ¼ in.
Cubical capacity	1,008	1,200
Truck wheelbase	5 ft. 6 in.	5 ft. 6 in.
Light weight	35,000 lbs.	39,000 lbs.

Most 50-ton steel coal cars have a cubical capacity of 1,700 cu. ft., which gives a rating of 59 lb. per cu. ft. of loading



Section of Underframe Showing Final Design for 50-Ton Wooden Coal and Ballast Cars

level full. On the above basis we obtain 1,200 by 59 = 70,800 lb. and twenty per cent for heaping we have 84,960 lb. With clay, gravel, stone, bricks, etc., it is possible to load the equipment to capacity.

If practical operating data is worth anything, it is certainly useful for comparative purposes, and should be used to arrive at definite limits to be followed in practice. In times like these, the mechanical department should conscientiously state the limit to which it may safely go in economizing in design and material. If a wooden coal car of large capacity is to be built, it is admittedly a mistake to allow

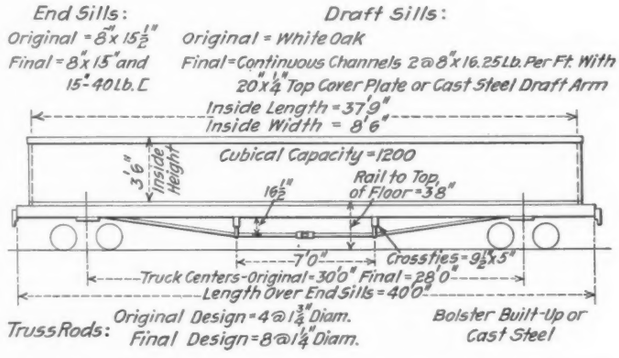
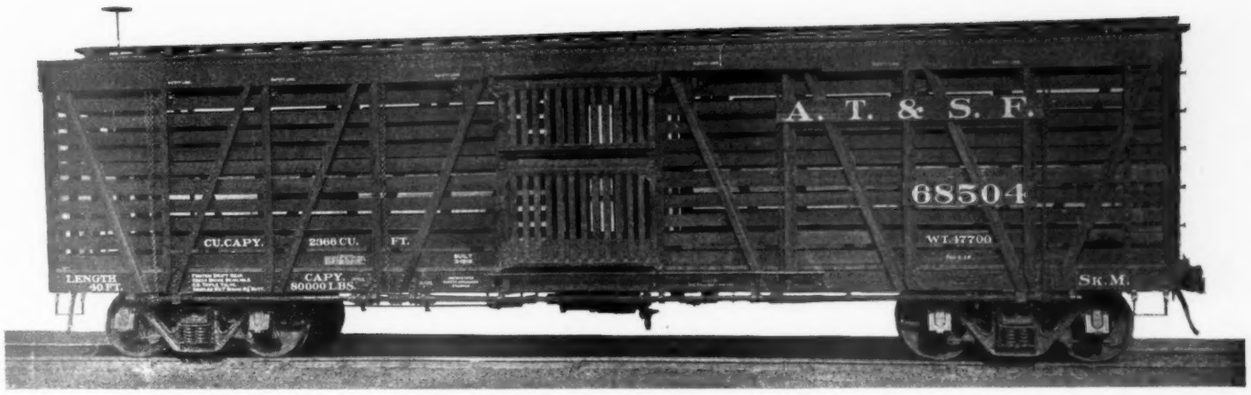

End Sills:
Original = 8"x 15½"
Final = 8"x 15" and 15"-40 Lb. C
Draft Sills:
Original = White Oak
Final = Continuous Channels 2@8"x 16.25 Lb. Per Ft. With 20"x¼" Top Cover Plate or Cast Steel Draft Arm
Inside Length = 37'9"
Inside Width = 8'6"
Cubical Capacity = 1200
3'6" Inside Height
16½"
Rail to Top of Floor = 3'8"
7'0"
Crossties = 9½"x5"
Truck Centers-Original = 30'0" Final = 28'0"
Length Over End Sills = 40'0"
Truss Rods:
Original Design = 4@1¾" Diam.
Final Design = 8@1¼" Diam.
Bolster Built-Up or Cast Steel

Diagram Showing Outline of Original and Subsequent Design of a Successful Wooden Coal Car, 900 of Which Are Now in Heavy Trunk Line Service

some of the sills to be eliminated and thus weaken the car, to provide for the application of drop doors, for the car will sag at the center and cause the doors to bind, making them ultimately useless.

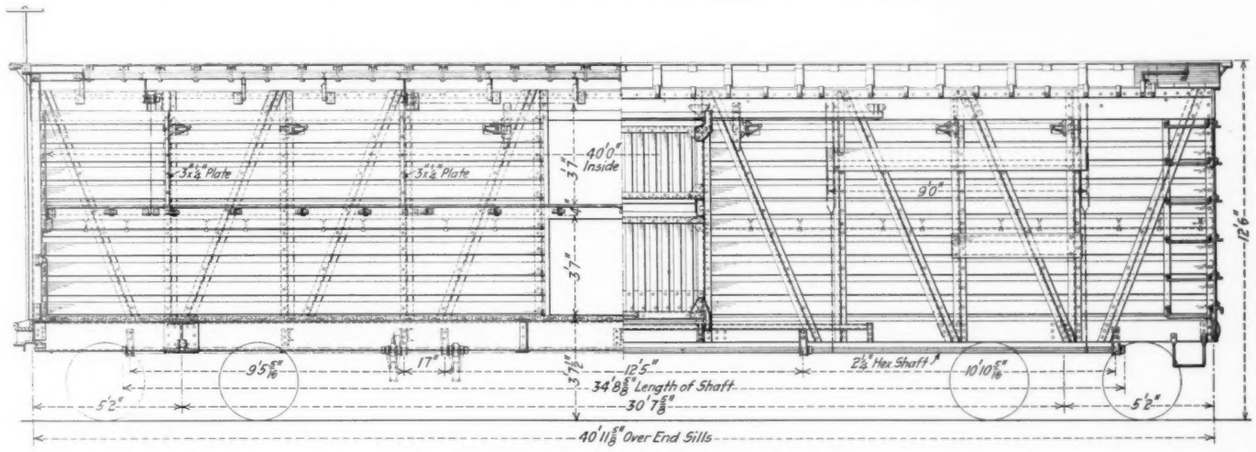
The purpose of this article is to call attention to the fact that the 50-ton wooden car is a compromise under the existing conditions and when built it must be developed along very definite limits of design. It should not be complicated with mechanisms which are obviously applicable only to equipment constructed partly or entirely of metal when its framing has been developed to work as a unit.



SANTA FE DOUBLE DECK STOCK CARS

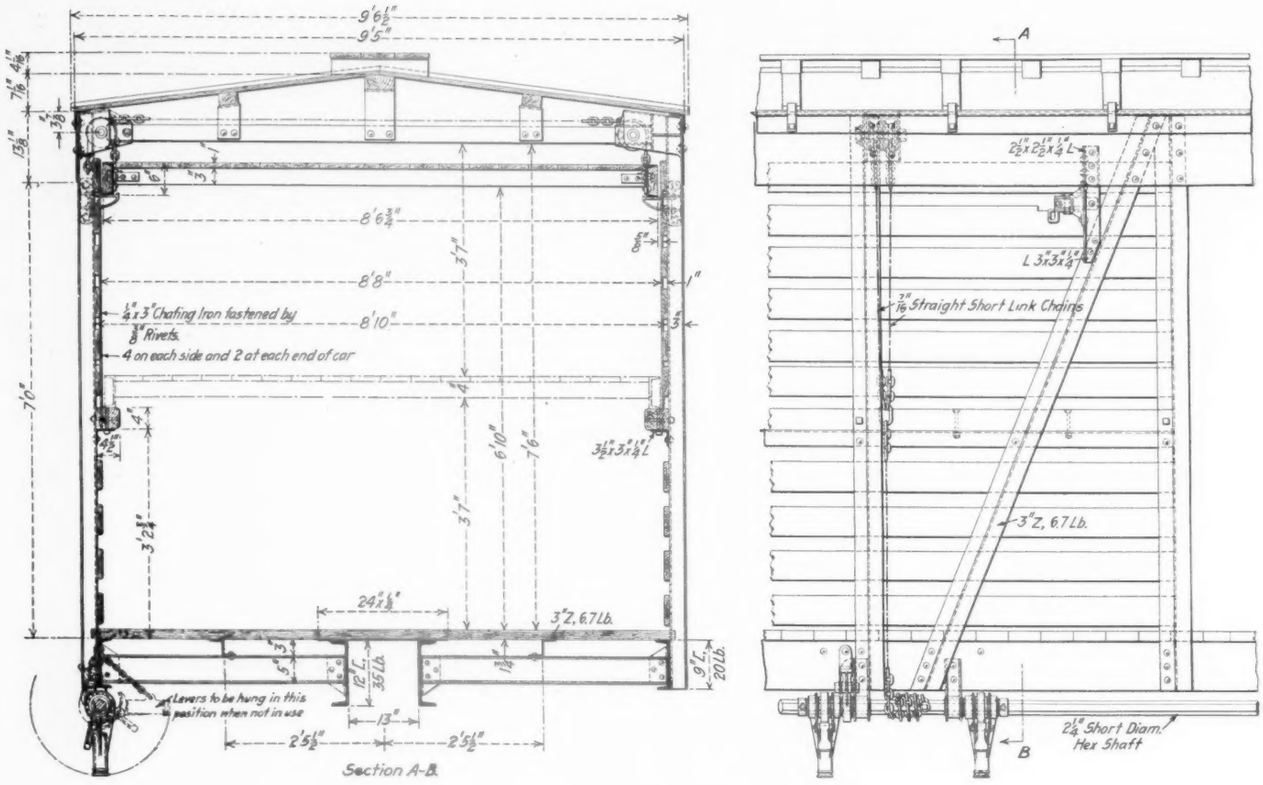
Movable Upper Deck in One Section Is Easily Raised; The Cars Are to Be Used for a Variety of Purposes

THE Santa Fe has had in use for over one year 500 stock cars which are of interest on account of the fact that they include several innovations in stock car construction. The chief feature of the cars is the movable upper deck, which rests on a belt rail, and can be raised by an arrangement of chains and winding shaft when the car is to be used as a single deck car. These cars, which are known in the railroad company's classification as the Class Sk M, are of 80,000 lb. capacity and have a light weight of 47,000 lb. The length inside is 40 ft. and they are 40 ft. 11⅝ in. long over the end sills and 43 ft. 9⅝ in. long over the couplers. The inside width is 8 ft. 8 in. and the width at the eaves 9 ft. 6½ in. The height from the rail to the top of the brake staff is 14 ft. 6 in. and to the top of the running board 12 ft. 6 in. When the upper deck is lowered the distance from the floor to the bottom of the upper deck is 3 ft. 7 in., and there is the same space between the upper deck and the underside of the carlines. With the deck in the raised position the distance between the floors and the under side of the deck is 6 ft. 10 in.

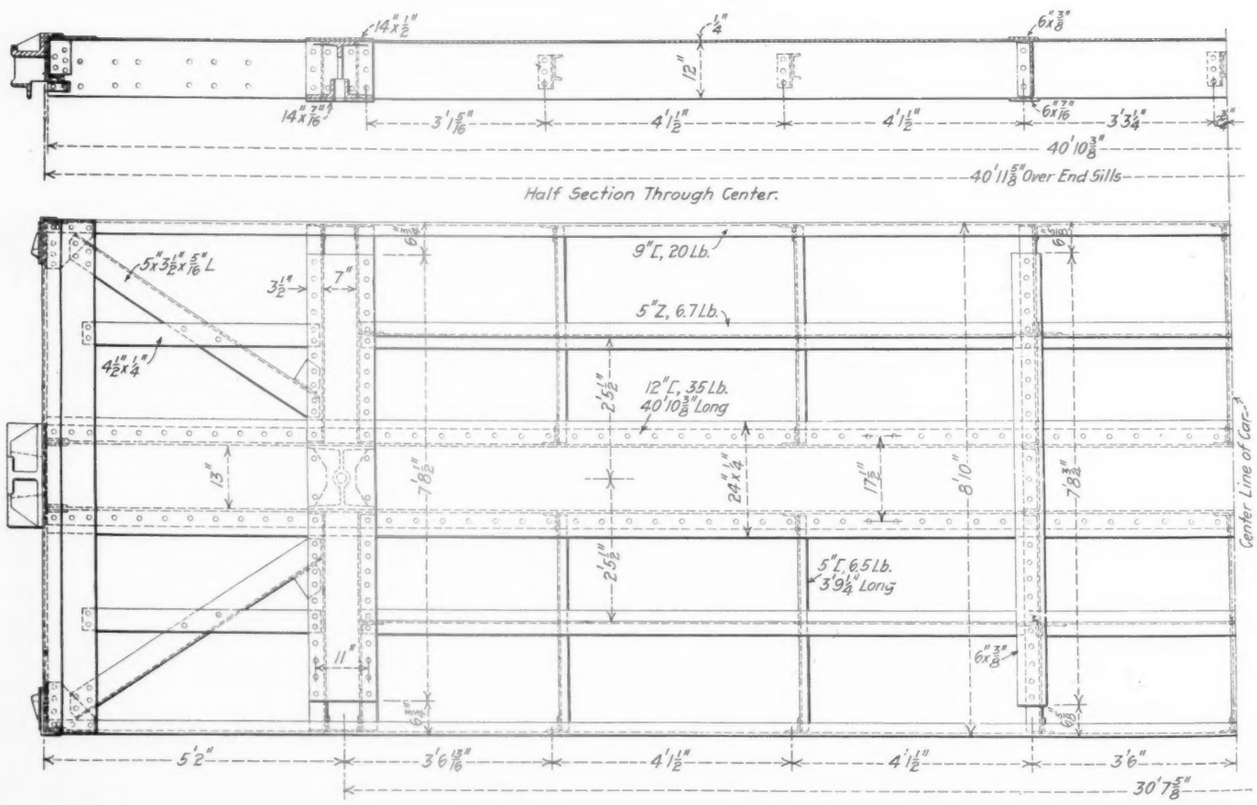


Elevation of Santa Fe Stock Car with Movable Decks

The car is designed with steel body framing, the sides forming trusses which carry the load, the center sills taking the buffing stresses only. The center sill is composed of two 12-in. ship channels, weighing 35 lb. per ft., spaced 13 in. from web to web, with a ¼-in. cover plate 24 in. wide extending the entire length of the sill. The body bolsters are of the box girder type, the sides being of pressed steel ¼ in. thick, spaced 7 in. between the webs. The body bolster cover plates are 14 in. wide, the upper plate being ½ in. and the lower 7/16 in. thick. Under the center of the body bolster is a ⅜-in. shim extending a short distance beyond the center sill channels, under which the drop forged center plate is riveted. A cast steel filler is placed between the center sill channels at the bolsters. The end sills are of 10-in., 30-lb. ship channels, with 5/16-in. end sill cover plates extending the full width of the car, connected to the under side of the top flange of the end sill channels and to the side sills. There are two main crossties of pressed steel ¼ in. thick, with a 6-in. by ⅜-in. cover plate on top and a 6-in. by 7/16-in. cover plate on the bottom. At each crosstie a pressed steel filler is placed between the center sill channels. The crossties are located 3 ft. 6 in. from the center of the car and with the end sills form auxiliary supports for the side framing, the main load being taken by the body bolsters. There are five small crossties of 5-in., 6.5-lb. channels, connected to the side sills and center sills by short angles. No spacers between the center sills are used at the small crossties. The floor supports are 5-in., 6.7-lb. Z-bars, extending between the bolsters. The sections are supported on the small crossties and fastened at the ends to the body bolsters and main crossties. From the bolsters to the end sills the floor is supported by 4½-in. by ¼-in. flat bars and by diagonal braces



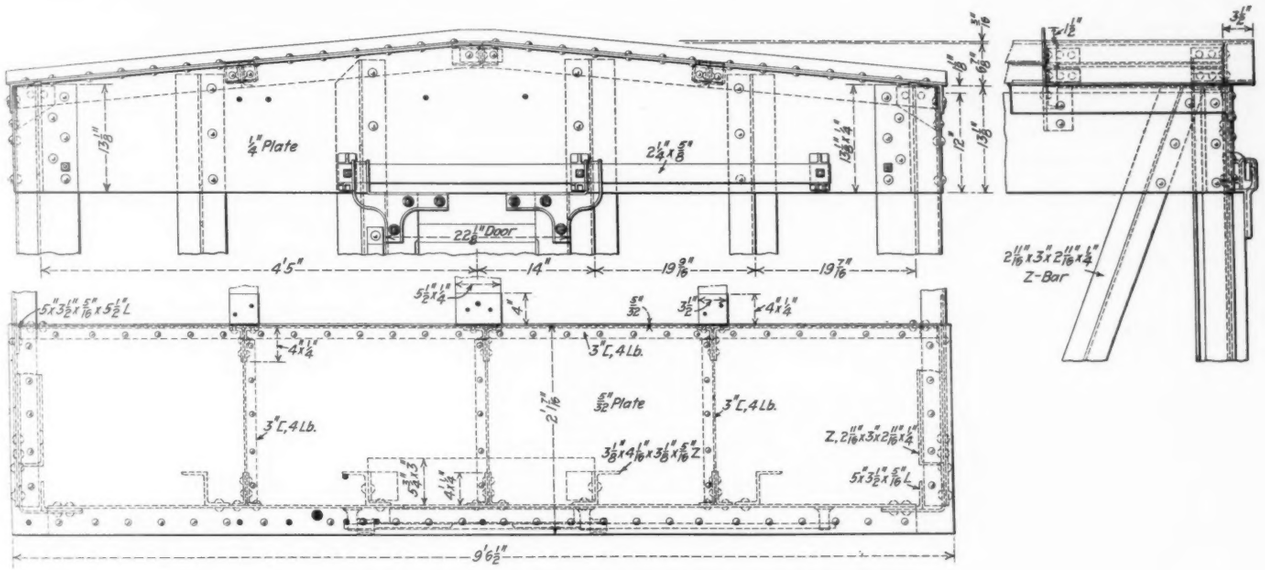
Cross Section Showing the Deck Operating Mechanism



Steel Underframe for Santa Fe Stock Cars

of 5-in. by 3½-in. by 5/16-in. angles extending from the sides of the end sills to the body bolsters.

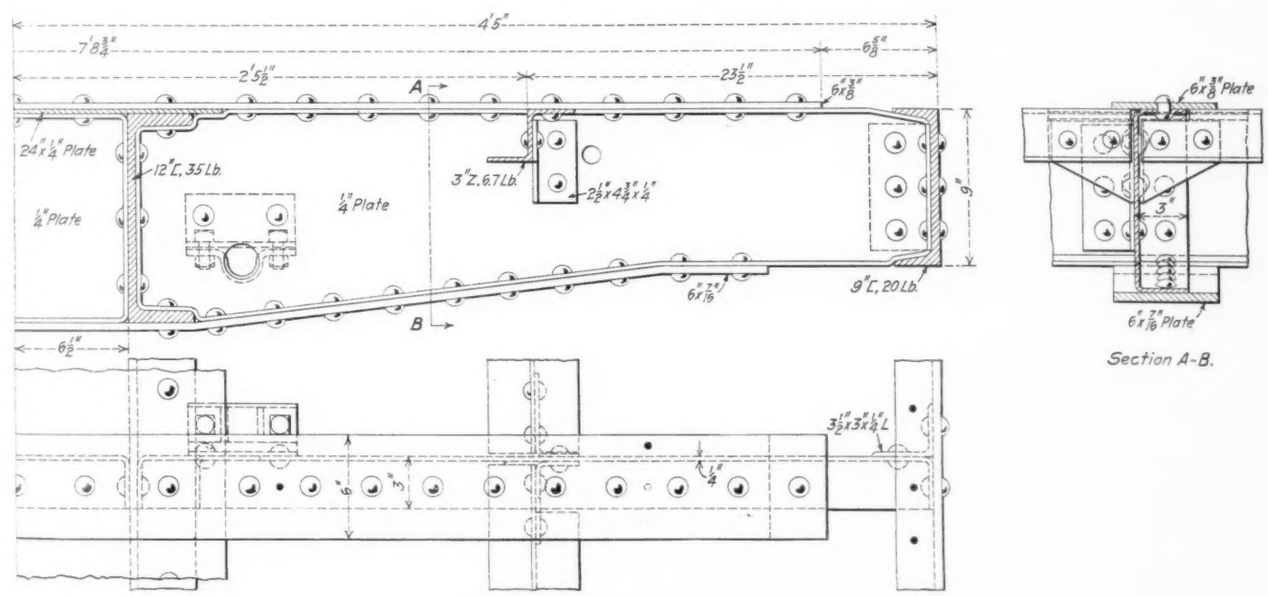
In the trusses which form the sides of the body frames the posts and braces have been fastened to the outside of the side sills and to the inside of the side plates, thus reducing the eccentric loading of the posts and braces. The side sills are



Detail of the Top End Connection for the Santa Fe Stock Cars

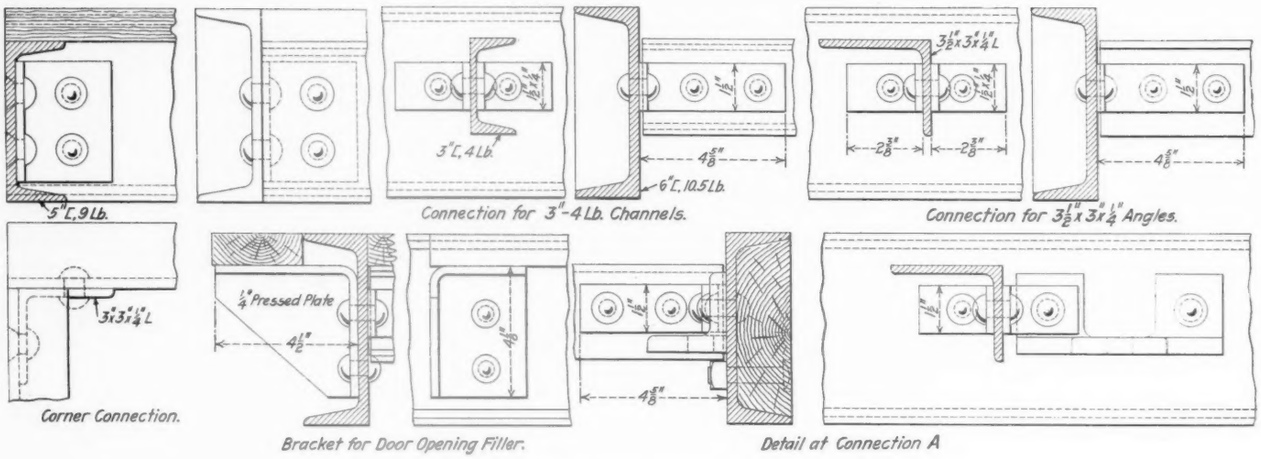
9-in., 20-lb. channels, extending between the end sills. The side posts and braces are of Z-bars ¼ in. thick, with 3-in web, weighing 6.7 lb. per ft. The door posts are also Z-bars, 5/16 in. thick, with 4 1/16-in. web, weighing 10.3 lb. per ft., while the corner posts are 5-in. by 3½-in. angles, 5/16 in. thick, weighing 8.7 lb. per ft. The side plate is formed of a 5-in. by 3½-in. by 5/16-in. angle, to which is riveted a flanged and extending out from the end posts 3½ in. The end of the roof of the car is formed by a ¼-in. plate 2 ft. 1 7/16 in. wide, riveted to the side plate angles and to the flange of the end plate. This roof plate is reinforced with three 3-in., 4-lb. channels, to the ends of which are fastened supports for the ridge pole and purlines. At the inside edge of the plate is a 1½-in. flange, over which the roof sheets are lapped. The carlines are 14 in number and are made of 3-in., 4-lb. channels. Ten of them are bent to the form of the roof and secured to the side plates with 5-in. by 3½-in. by 5/16 in. angles. The other four are straight and are riveted to the malleable roller housing brackets.

The flooring is 1¾-in. square edge long-leaf yellow pine

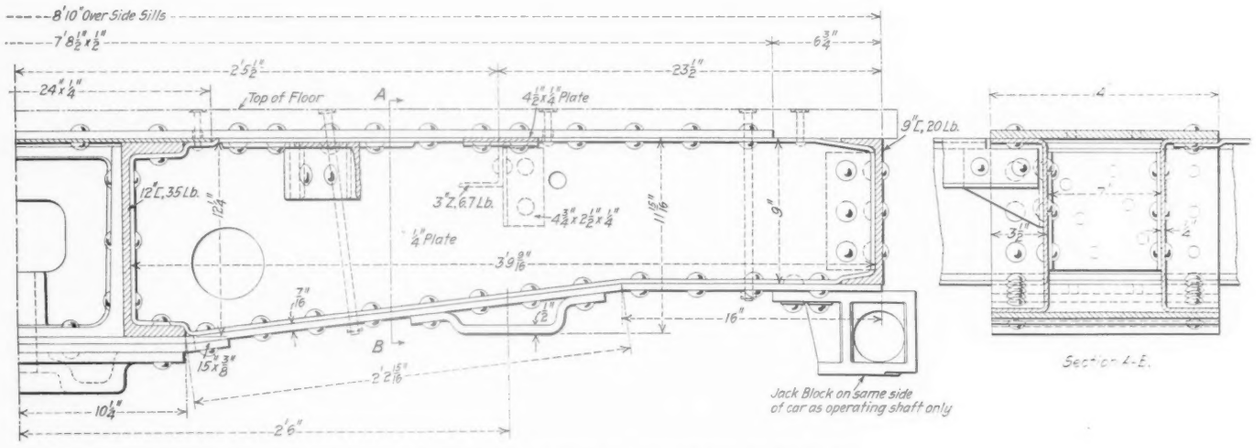


Details of Main Crosstie—Santa Fe Stock Car

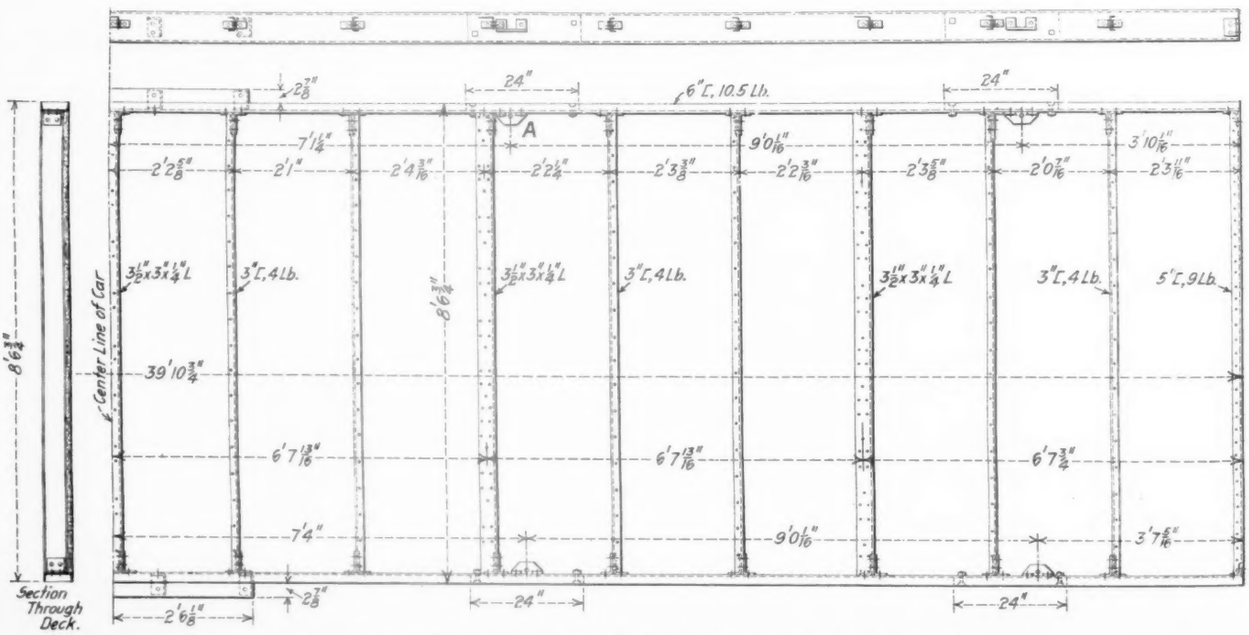
¼-in. plate 12 in. wide, this plate forming a connection for the posts, braces, door tracks, etc. The end posts are four Z-bars 5/16 in. thick, with a 4 1/16-in. web, weighing 10.3 lb. per ft. To the top of the end posts is riveted a ¼-in. plate, 13⅛ in. wide at the side plate, with the upper edge riveted to the underframe with ⅜-in. wagon box rivets. The slats are of the same material, those on the sides being 1 in. by 5½ in., while on the ends they are ¾ in. by 5½ in. The slats are secured to the doors, sides and end posts with wagon box rivets and to the corner posts and fillers



Details of the Movable Upper Deck—Santa Fe Stock Car



Section Through Body Bolster—Santa Fe Stock Car



General Arrangement of the Movable Upper Deck for the Santa Fe Stock Car

with carriage bolts. The roof boards are 13/16 in. by 5¼ in. tongued and grooved, supported by the ridge pole and by one purline on each side of the car. The roof is of the standard Railway Equipment Company's flexible metal type, the sheets being No. 25 Birmingham gage. Outside metal roofs were applied to these cars so that they could more readily be made available for loading with wheat by lining with paper. It is planned to use these cars in that way in case of a shortage of grain cars.

The side door opening is 5 ft. 1 in. by 6 ft. 10 in. Separate side doors are provided for the upper and lower decks, the upper doors being suspended on ⅝-in. by 2¼-in. tracks, while the lower doors run on tracks of 1½-in. heavy steel pipe, which sets below the floor. End doors are provided for both the upper and lower decks.

The movable upper deck is in one section. The sides of the frame are 6-in., 10½-lb. channels and the ends are 5-in., 9-lb. channels. There are five cross beams of 3½-in. by 3-in. by ¼-in. angles, between which are two 3-in., 4-lb. channels also running transversely. The floor is of 1-in. yellow pine running lengthwise, bolted and riveted to the cross beams. A bracket extends out from the frame at the door openings to prevent stock getting their feet between the door and the deck. The deck when lowered rests on yellow pine stringers supported by 3½-in. by 3-in. by ¼-in. angle irons extending around the car and riveted to the posts and braces.

On each side of the movable deck four 7/16-in. chains are attached. These chains run up to the side plates, where they pass over pulleys. The chains from one side are carried across the car where they run over another pulley and are joined to the opposite chain which is carried down to the operating shaft. The location of the operating chains is shown by the dotted lines on the side elevation. The operating shafts extend a short distance beyond the bolsters at each end of the car. Attached to the shaft near the door openings are two levers and a detaining pawl. The levers have ratchets and pawls for controlling the ascent or descent of the deck. The fact that there is but one operating shaft greatly facilitates the work of moving the deck. It has been found that one man can raise or lower it, either operation being performed in two minutes. On future orders but one operating lever will be provided. To hold the deck in raised position there are six malleable iron brackets on each side of the car, which can be swung in under the channels which form the side of the frames and locked by pawls. Patents have been granted on the devices for operating the movable upper decks.

These cars have Andrews cast steel side frame trucks with a wheel base of 5 ft. 4 in. and cast steel truck bolsters. The draft gear is of the friction type, Miner Class A-19-B. The couplers have 5-in. by 7-in. shank and 9⅛-in. butt. The air brake is the Westinghouse schedule K C-1012.

IMPORTANCE OF PROPER LOADING OF CARS*

BY W. H. BETTCHER
Master Car Builder, Cincinnati, Indianapolis & Western, Indianapolis, Ind.

Accepting or running a car improperly loaded may mean a disastrous wreck, the loss of human life, a large monetary loss, tying up the railroad for many hours, the expensive cost of transferring loads, and in addition to all this it will create ill feeling between interchange inspectors concerning the transferring of loads. Great care should be taken in selecting cars for loading. Where improper cars are used there is considerable extra work for the various departments of the railroad, and the shippers are liable to suffer. It causes delayed shipments and claims which many times mean a large loss to the railroad.

How many keep thoroughly conversant with the M. C. B. Loading Rules, and how many make it an important part of their business to go to the shipper and show him how to load the material he is about to ship, or to assist him in procuring the proper cars? While passing through Illinois one day last June I noticed a shipper loading a load of logs in such a way that no good thinking inspector would have accepted them in interchange. I told him in a kindly way that he was loading his logs improperly. It seemed that he had never received the rules governing the loading of logs, and he said he would be only too glad to read them. I left a copy with him and from that time we have never received a bad load of logs from this point. No doubt some shippers will want to be arbitrary, but he who is held responsible must show this sort of man that we mean business, and that the load will have to be loaded properly and in accordance with the rules. Car inspectors should keep the loading rules ever before them as a safeguard against loss of life, loss of lading and damage claims.

* From a paper read before the annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association, Indianapolis, Ind., October 3, 4 and 5, 1916.

REDUCING BREAKS-IN-TWO ON THE SANTA FE

In discussing the handling of trains before the Car Foremen's Association of Chicago, H. R. Lake, trainmaster of the Santa Fe at Emporia, Kansas, told of the measures which have been taken to reduce the number of breaks-in-two on the eastern division. Each month a circular is issued showing the number of breaks-in-two for the preceding month, with a comparison with the figures for the last six months and the general average for the year. In another tabulation is shown the breaks-in-two charged to each engineman for the preceding two months following which is the record of each engineman for the year past. The breaks-in-two are classified between freight and passenger trains and also as to whether they occurred while starting, stopping or running. The percentage of the trains operated on which breaks-in-two occurred and the percentage of the totals for which each individual engineman was responsible are given. A further classification according to the cause as ascertained by investigation shows in detail the causes which contributed to the parting of trains.

The analysis of the breaks-in-two for the year 1916 showed that of the total number 45.5 per cent occurred while trains were stopping, 24.5 per cent while trains were starting, 27.2 per cent while running and 2.8 per cent while switching.

The contributing causes in detail were as follows:

Draft gear:	
Drawbar pulled out	22.8 per cent
Drawbar broken	11.6 per cent
Draft timbers pulled out	8.8 per cent
Sleeve bolts broken	5.1 per cent
Defective draft bolts and timbers, broken tail pins, broken continuous rod	5.0 per cent
Total	53.3 per cent
Couplers and uncoupling devices:	
Knuckle broken or defective	12.3 per cent
Defective couplers and drawbars	5.1 per cent
Knuckle opened	5.1 per cent
Knuckle worn	4.4 per cent
Defective lock block	4.0 per cent
Lift lever raised, lift rod key broken or defective, short uncoupling chain	2.7 per cent
Total	33.6 per cent
Air brake:	
Burst air hose	6.2 per cent
Air set from rear, defective triples and train lines	3.3 per cent
Total	9.5 per cent
Miscellaneous:	
Carrier irons down, low drawbars, cars buckled, etc.	3.6 per cent

On account of the circulars on breaks-in-twos marked reduction in the number has been effected.

SHORTAGE OF COAL IN DENMARK.—Denmark possesses no coal mines, and supplies must be imported, amounting to about 3,500,000 tons annually. The closing of English ports make the country depend on Germany for its supply.

AIR BRAKE ASSOCIATION CONVENTION

THE Air Brake Association met for its twenty-fourth annual convention at the Hotel Chisca, Memphis, Tenn., May 1-4, 1917, T. W. Dow, of the Erie Railroad, presiding. At the opening session T. C. Ashcroft, mayor of Memphis, welcomed the association.

PRESIDENT'S ADDRESS

In his address Mr. Dow emphasized the necessity of having close co-operation between the railway mechanical organizations and dwelt on the importance of careful deliberation in matters pertaining to the reports and recommendations of the association. He also spoke of the demands which will be made on the railroads during the war, which render it imperative that the utmost efficiency be secured in all branches of the service and particularly in the air brake.

FUNCTIONAL INTERRELATION BETWEEN THE COMPONENT PARTS OF THE AIR BRAKE SYSTEM

BY W. E. DEAN

Because of the complexity of the air brake system, many people, in their close attention to one phase of the air brake problem, overlook the other phases. For instance, many relate wheel sliding directly to braking power or braking ratio, and forget that there are many more factors involved. Again, air brake devices frequently are given close scrutiny as to the delivery and release of air at the brake cylinder, without tracing the braking problem right on through from that point to the wheel and to the rail. It may be surprising to state that the air brake system for a train not only includes the more obvious parts such as air compressor, triple valve, etc., and the foundation brake gear, but also the truck and car construction, the wheels and the rails, and even the road bed and the weather. In applying brake shoes to a pair of wheels a balance of equal frictional forces is set up, the brake shoe friction tending to slide the wheels, and the wheel-rail friction keeping the wheels in rotation. However, if the brake shoe friction exceeds the maximum possible wheel-rail friction, or adhesion, that is, if the pull of the brake shoes tending to lock the wheels is a greater force than the pull of the rail, which tends to keep the wheels turning, the wheels, of course, will slide. Figs. 1 and 2 portray the relation between adhesion, braking ratio and efficiency factor in this balance of forces. By "adhesion" is understood the *limiting* value of adhesion between wheel and rail beyond which more thrust or resistance cannot be given by the rail. The limiting value for adhesion will depend on the condition of the wheel and rail surfaces in contact, which in turn is dependent on many things: weather conditions (humidity and temperature); foreign substances, such as sand or frost, etc. A value of 25 per cent is the average generally taken for a clean dry rail, though it may go as high as 30 or 35 per cent with the presence of sand or as low as 12 or 15 per cent where frost is found.

By "braking ratio" is understood the relation between

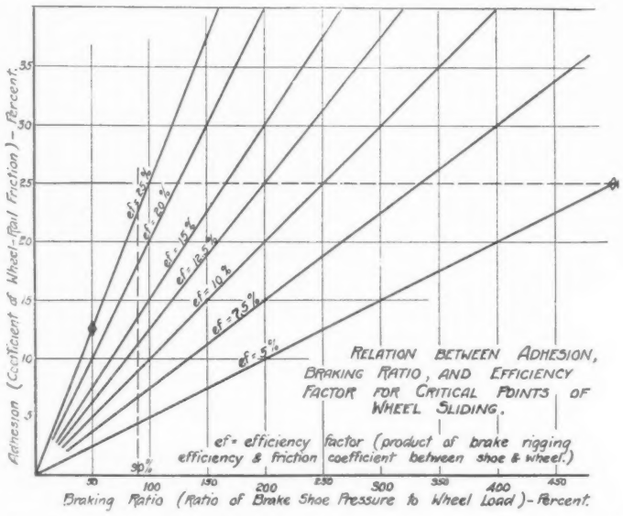

Adhesion (Coefficient of Wheel-Rail Friction)-Percent.
Braking Ratio (Ratio of Brake Shoe Pressure to Wheel Load)-Percent.
ef=25%
ef=20%
ef=15%
ef=12.5%
ef=10%
ef=7.5%
ef=5%
RELATION BETWEEN ADHESION, BRAKING RATIO, AND EFFICIENCY FACTOR FOR CRITICAL POINTS OF WHEEL SLIDING.
ef= efficiency factor (product of brake rigging efficiency & friction coefficient between shoe & wheel.)

Fig. 1—Relation Between Variables Determining Critical Point of Wheel Sliding

the nominal braking force applied to a pair of wheels and the weight on those wheels. We speak of "nominal" braking force because the braking ratio does not consider losses in force transmission from the brake cylinder to the wheels.

In order to find what this braking force means in the way of brake shoe pull on the wheels it is necessary to multiply it first by the efficiency of the brake rigging and then by the coefficient of friction between shoe and wheel. The com-

bination, or product, of this rigging efficiency and friction coefficient is called the "efficiency factor". The braking ratio for a car multiplied by this efficiency factor gives the retardation factor, or actual retarding force in percent of the car weight. When this retarding force tends to exceed the limiting adhesion the wheels will slide.

Whether or not wheels slide, therefore, depends on the adhesion and the efficiency factor as well as on the braking force. Reference to Fig. 1 will show that where the adhesion is 25 per cent wheels may slide with anywhere from 100 per cent braking ratio (where the efficiency factor is 25 per cent) to 500 per cent (where the efficiency factor is but 5 per cent). Again, wheels may slide with 50 per cent braking ratio where the adhesion is but 12.5 per cent and the efficiency factor is 25 per cent. From this it is readily appreciated that wheel sliding is not solely dependent upon braking ratio.

Fig. 2 illustrates the same relations in another way. It is here seen that with a constant adhesion the braking ratio required to slide wheels will be decreased in proportion as the efficiency factor increases.

There is one phase of wheel sliding which has received scant attention, viz., the inability for a six-wheel truck to equalize weight freely from one pair of wheels to another when a brake equipment is used which applies a heavy unbalanced shoe pressure to one side of a wheel only. When a single brake shoe is applied to a wheel the side thrust must be opposed finally by the opposite pedestal jaw. The friction between this jaw and the journal box prevents the latter from moving up or down freely, with the result that the weight on that pair of wheels may be suddenly relieved in passing over a low spot in the track, and the wheels slid. To keep the braking force the same and decrease the weight is in effect to increase correspondingly the braking ratio. If the balance of forces is in the neighborhood of the adhesion limit the wheels are very likely to slide. The remedy here is to balance this brake shoe pressure by applying a similar brake shoe pressure from the other side. In other words, it is to use a clasp brake with equal and opposite shoe pressures on each side of the wheel. To have these two opposing shoe pressures differ in value is only to temporize, or dally with, the problem.

In connection with wheel sliding mention was made of braking ratio and efficiency factor. There is an important interrelation between braking ratio, type of foundation brake gear, type of brake shoe, efficiency factor and speed, which is illustrated in Fig. 3. This is a graphical summary of the values for efficiency factors given by S. W. Dudley in a paper presented before the American Society of Mechanical Engineers in New York, February 10, 1914. These values were selected from some of the best stops which were made in 1913 during the extensive Atlantic City Brake Tests of the Pennsylvania Railroad.

You will note that the efficiency factor decreases as the braking ratio is made greater. For instance, the efficiency factor for 125 per cent braking ratio, the clasp brake and a

T. W. Dow (Erie)
President

C. H. Weaver (N. Y. C.)
Vice-President

F. J. Barry (N. Y. O. & W.)
Vice-President

F. M. Nellis (W. A. B. Co.)
Secretary

Otto Best (Nathan Mfg. Co.)
Treasurer

OFFICERS OF THE AIR BRAKE ASSOCIATION

speed of 60 m.p.h. is .103. For 180 per cent braking ratio it is only .085, all other things remaining the same. You will note as well that the efficiency factor is higher the lower the speed, with any given conditions of braking ratio, type of brake shoe and foundation brake gear. The type of brake shoe, whether plain or flanged, will also affect the value of the efficiency factor as shown in the scale of abscissae at the

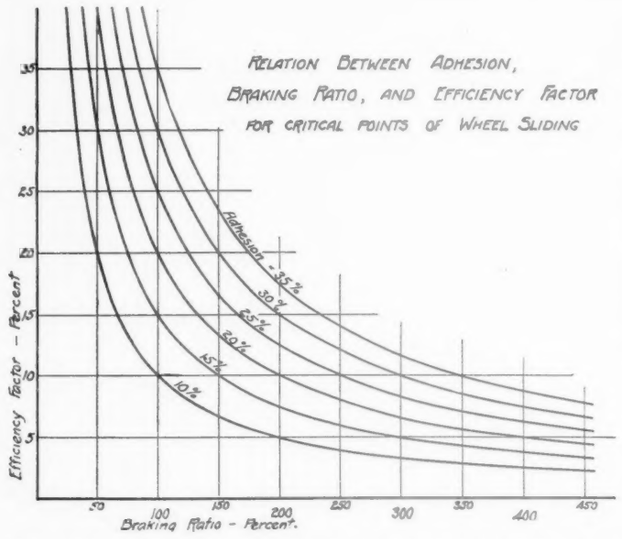


Fig. 2—The Relations Shown in Fig. 1 Illustrated in Another Way

bottom of the chart. The efficiency factors for the flanged shoe are in every case about 20 per cent higher than for the plain shoe. The successful use of the flanged shoe, however, seems to be limited to the clasp brake because of wheel flange troubles and slid flat wheels arising in its use with the single shoe brake. And finally it will be observed that in every case the efficiency factor for the clasp brake is higher than for the single shoe brake.

A functional interrelation of great interest to those who

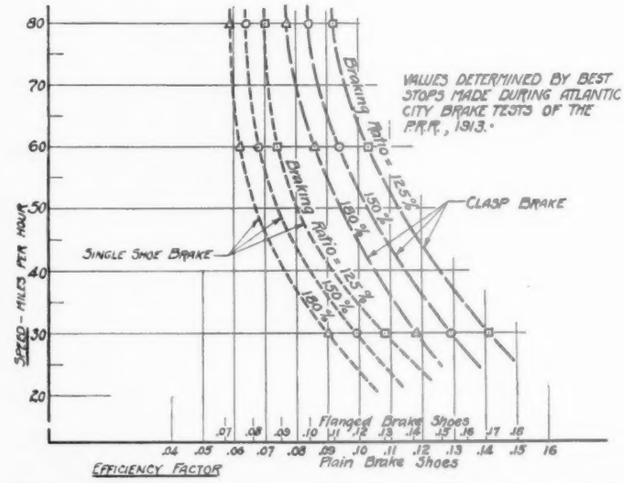


Fig. 3—Efficiency Factors for Stops from Various Speeds With Clasp and Single Shoe Brake Gears and Plain and Flanged Shoes

have to deal with the air brake problem is the one existing between the stop distance for a train, on the one hand, and the speed of the train, the grade, the braking ratio, the efficiency factor, and the time required to get the brakes applied, on the other.

Fig. 4 illustrates this interrelation in a graphic manner. The first line gives the basic, or 100 per cent, conditions to afford a basis for all comparisons. The speed is 60 m.p.h., the track level, the braking ratio 150 per cent, the efficiency factor 8.5 per cent, and the mean time required to get the brakes into action is 0.7 second. Where these conditions hold the stop distance will be 1,000 feet. In each case these basic conditions hold except where otherwise noted.

Due to the close interrelation and balance in functions existing between the many parts which go to make up the air brake system, care must be exercised to see that a change in one part, more or less desirable, does not introduce changes

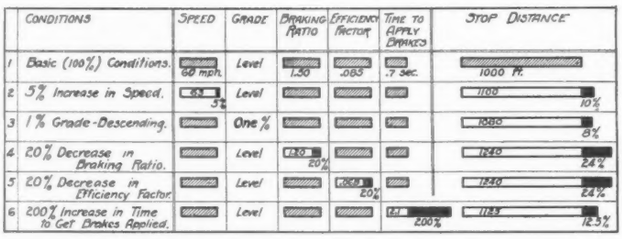

Conditions
Speed
Grade
Braking Ratio
Efficiency Factor
Time to Apply Brakes
Stop Distance
1 Basic (100%) Conditions. 60 mph. Level 1.50 .085 .7 Sec. 1000 Ft.
2 5% Increase in Speed. 5% Level 10%
3 1% Grade-Descending. One % 8%
4 20% Decrease in Braking Ratio. 20% 24%
5 20% Decrease in Efficiency Factor. 20% 24%
6 200% Increase in Time to Get Brakes Applied. 200% 12.5%

Fig. 4—Effect on Stop Distance of Variations in Speed, Grade, Braking Ratio, Efficiency Factor and Time to Get Brakes Applied

elsewhere which would render useless or quite defeat the good effects desired.

Frequent reference has been made to the superior performance of the clasp brake as compared with that of the single shoe brake. It must be stated with much emphasis, however, that in every case reference was made to a clasp brake designed and installed on correct engineering principles. A clasp brake improperly designed and poorly installed, as for instance on a truck the construction of which does not lend itself to a suitable clasp brake, may not only fail to deliver the performance desired but may actually be less satisfactory than the single shoe brake which is displaced.

CLEANING AND LUBRICATING BRAKE CYLINDER PACKING LEATHERS

BY R. C. BURNS

In the past it has been the practice when cleaning brake cylinder piston packing leathers to remove the non-pressure head and piston and thoroughly clean the piston and leather at the car on the repair, or shop track, and in many cases, kerosene oil is used to clean the brake cylinder packing leather, as it is almost impossible to remove the heavy grease from the leather without the use of some mineral oil, especially during cold weather, which seriously affects the leather filler, and as a result, leathers are placed in cylinders which show no visible defects, but fail when making the brake cylinder leakage test, after being in service a short time.

In order to eliminate these improper practices and to afford better facilities for cleaning and testing these leathers, the piston and leather should be taken to a shop provided with the proper facilities for cleaning and testing, in order that they may receive the same careful attention as is now recommended for triple valves. When transmitting the piston and leather to the shop, care must be taken to provide a suitable shield to protect it from damage either by coming in contact with other devices or from dirt.

When cleaning the brake cylinder packing leather, the follower plate should be removed and the leather thoroughly cleaned, without the use of any mineral oil, and if no visible defects are found, the leather should be re-applied to the piston and tested in a cylinder of standard size for the leather under test. The cylinders of the various sizes

to be used for conducting these tests should be equipped with apparatus in order to conveniently conduct the test, similar to that shown in Fig. 1.

An S-3 brake valve is employed for admitting air to the brake cylinder when conducting this test as this valve can be more conveniently and accurately operated for admitting and discharging air to and from the cylinder than two standard cutout cocks otherwise required. The feed valve is adjusted to 55 lb., which pressure is admitted to the cylinder, and the readings noted from an initial cylinder pressure of 50 lb., in order to avoid any false leakage due to the change in the temperature of the air.

The special apparatus above referred to for testing brake cylinder piston packing leathers is designed to provide for a 6-in. piston travel, whereas, the Proceedings of the Master Car Builders' Association, Volume 50, Part 2, for the year 1916, on page 810, states that the piston travel should be adjusted to not less than 5½ in. or more than 7 in. On this same page, it also states brake cylinder leakage must not exceed 5 lb. per minute from an initial cylinder pressure of 50 lb., while on page 830, it specifically states that all tests must be made with an 8-in. piston travel, except when

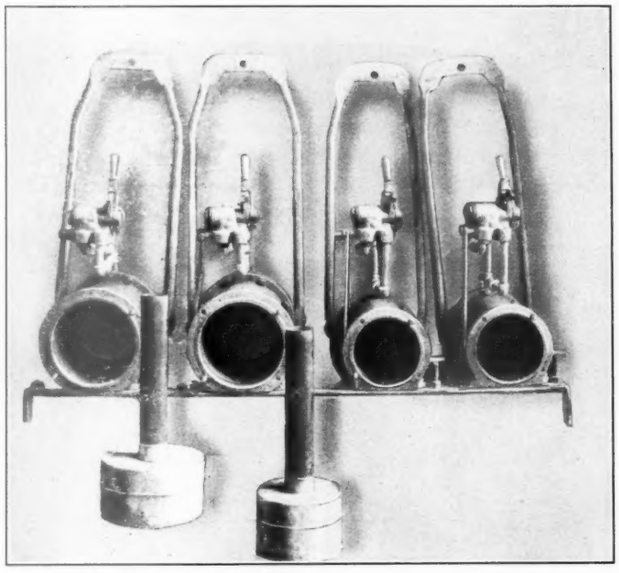


Fig. 1—Cylinders for Testing Packing Leathers

otherwise specified. This is rather confusing, and we would suggest that brake cylinder leakage tests be made with a piston travel of 6 inches.

We would also recommend that an additional brake cylinder leakage test be provided for cars arriving on repair tracks that are not due for periodical attention to the air brake equipment, as follows: The air brake equipment to be inspected, tested and the necessary repairs made, and the brake cylinders tested, and if the leakage exceeds 12 lb. per minute from an initial cylinder pressure of 50 lb. with a 6-in. piston travel, the cylinder and leather should be given the necessary attention.

When the brake cylinder is given attention, the expander ring should also receive a careful inspection and test by the use of a special gage.

The above practice as outlined for the cleaning, lubricating and testing of brake cylinder packing leathers has been followed on one particular railroad for a period of about one year and the results obtained have been very satisfactory. When the piston and leather have been applied to the brake cylinder on the car, the present standard test should be made to eliminate all possible leakage which may exist in the brake cylinder pressure head and its connecting pipe.

The leathers which were condemned by these tests, but could not be condemned by a visual inspection, were forwarded to the manufacturer to be re-treated, and after being returned, they were placed in service together with the new leathers for a comparative test which followed for a period of six months, with the result that in no case did the leakage of the re-treated leather exceed the leakage of the new leather. There is no question but quite a large percentage of discarded brake cylinder packing leathers can be reclaimed by this re-treating process.

DISCUSSION

Attention was called to the saving which this method would effect when a large number of packing leathers are cleaned. The present condition of the leather market makes it particularly desirable to reclaim packing leathers whenever it is possible.

RECOMMENDED PRACTICE

Under heading "Air Compressors," sub-heading "Location," the following should be added. Paragraph No. 1: The base of the bracket should have ample length and bearing on the boiler to insure adequate compressor support as well as to prevent injury to the boiler.

Paragraph No. 3. The number, size and spacing of the studs for securing the bracket to the boiler should be according to good engineering practice; the number and size of studs to depend upon the distance the compressor is out from the boiler. It is recommended that not less than six 1⅛-in. studs properly spaced be used where the compressor is hung low.

Under sub-heading "Repairs to Air Compressors," the following to be added as Paragraph No. 2: Air Compressors returned to the shop for repairs should be thoroughly cleaned in boiling lye before dismantling for inspection.

Under sub-heading "Repairing and Condemning," the following should be added to Paragraph No. 4: Dimensions between piston heads when properly assembled to be as follows: 9½-in. compressor—18.675; 11-in. compressor—21.175; 8½-in. cross compound compressor—22.675.

Paragraph No. 5 to be changed to read: Piston packing rings for steam cylinders to be condemned when end of rings are 3/32 in. apart when placed in the smallest part of the cylinder.

The following paragraphs to be added: Piston packing rings for steam cylinders to be condemned when end of rings do not come together when placed in the smallest part of the cylinder.

Combinations of packing rings and air pistons should not be used when the difference between the thickness of the ring and the width of the groove is .005 in. or more.

Under heading "Brake Valves," sub-heading "Cut Out Cocks," Paragraph No. 1 to be changed to read: The double heading cut-out cock of the engineer's brake valve to be located in the cab and so placed that the handle points upward when cut out and turns down against the lug so that it stands crosswise of the pipe when cut in. If conditions prevent the use of a handle of full length, it should be cut off but in no case to be less than 2¾ in. long.

Under heading "Distributing Valve," sub-heading "Location," Paragraph No. 1 following the word "brackets" in the fourth line, the following words should be added: "bolted to the boiler, if possible."

Paragraph No. 2 to be omitted as this is included in Paragraph No. 1.

The following paragraph to be added: Distributing valve should be maintained in a condition to apply with a 5-lb. brake pipe reduction made with the automatic brake valve and to enable pressure to be graduated out of the brake cylinders in steps of about 8-lb. at a time.

The following paragraph to be added: Distributing valve

to be removed from the locomotive at least once in each six months, thoroughly cleaned, examined and tested in accordance with the prescribed code on the standard test rack.

Under heading "Brake Cylinders," sub-heading "Cleaning and Lubricating," Paragraph No. 2 to be changed to read: Packing leathers must not be cleaned with kerosene or any mineral oil, or with waste or rags that have been soaked in kerosene or mineral oil, as this destroys the filler placed in the leather by the manufacturers, opening the pores and causing the leather to become soft and porous.

Under sub-heading "Leverage," Article No. 6, the word "piston" to be changed to read "position."

Paragraph No. 10 should be omitted and the following paragraph substituted: Clasp brakes of proper design should be used on all passenger equipment cars.

The following paragraph should be added to follow Paragraph No. 11: Foundation brake gear on freight equipment cars to be suitable to withstand brake cylinder pressure of 85 lb., except where the empty and load brake is applied when 60 lb. cylinder pressure in both cylinders should be used as a basis in determining the strength of the rigging.

The following paragraph to be added: When locomotives or cars are in shops for general repairs, the foundation brake rigging should be thoroughly inspected and all excessive lost motion eliminated. All pins should be removed for inspection, pin holes trued up and new pins applied wherever necessary.

The feed valve test and the distributing valve test were also revised and the M. C. B. recommendations for hand brakes and brake beams were adopted. Some additions and changes to conform to the practices required by federal laws and various minor revisions of the code were made.

The report was signed by S. G. Down, chairman; H. A. Wahlert, N. A. Campbell, J. R. Alexander and H. A. Clark.

OTHER BUSINESS

There were more than 200 members registered and 150 guests. The secretary reported a good increase in the membership and also in the balance in the treasury during the past year. The association voted a considerable fund to be given to the American Red Cross. Papers were also presented on the Slack Action in Passenger Trains, Handling Trains on Heavy Grades, and the Life of Hose. These will be published later.

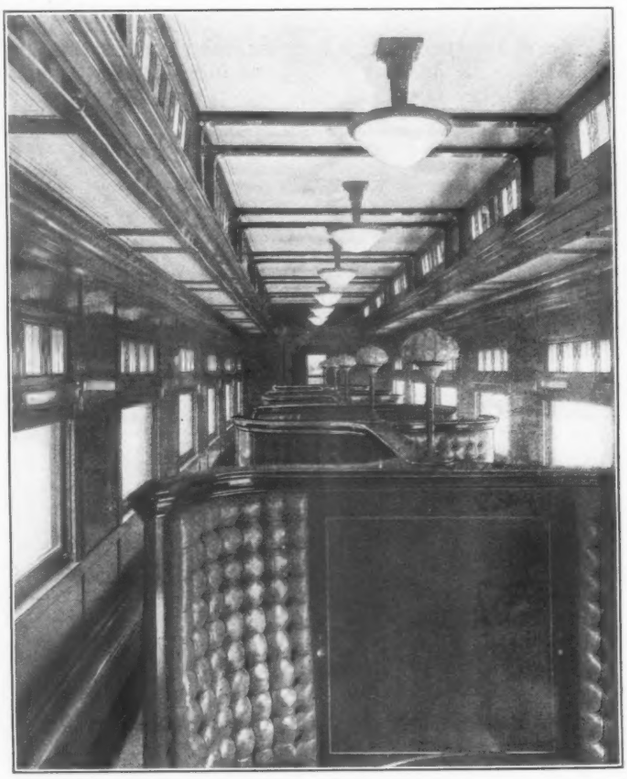
On Thursday Walter V. Turner gave a lecture, illustrated with moving pictures, on the operation of a triple valve and also showed lantern slides of freak inventions. On Wednesday Mr. Turner gave a lecture on the manufacture of shrapnel shell.

The following officers were elected: President, C. H. Weaver, N. Y. C. West of Buffalo; first vice-president, C. W. Martin, P. R. R.; second vice-president, F. J. Barry, N. Y., O. & W.; secretary, F. M. Nellis, Westinghouse Air Brake Co.; treasurer, Otto Best, Nathan Manufacturing Co.

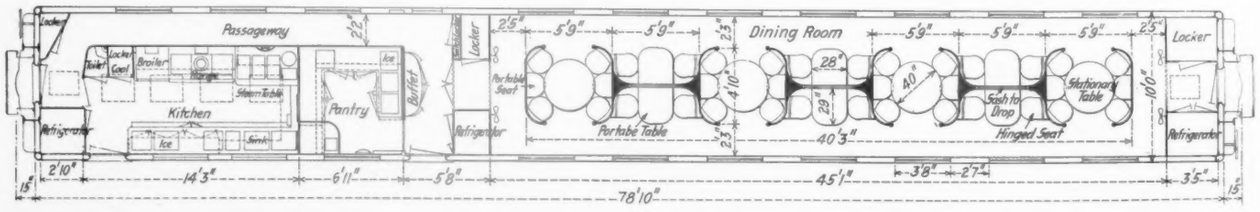
ERIE DINING CARS WITH UNIQUE TABLE ARRANGEMENT

The Erie Railroad now has in service two new dining cars designed to give privacy to each two or four guests, as the case may be, and they were recently exhibited by the company to a number of railway men and other guests at the Jersey City terminal. As the illustration indicates, the passengers sit facing one another within semi-enclosed compartments which occupy the central line of the car. There are two aisles—one on either side of the compartments. When seated the passenger is screened from view of all except persons passing in the aisle, and he has a good out-door view through the window at his side. The compartments accommodate 28 passengers; four persons may be seated at each of four tables and two persons at each of six tables. This arrangement greatly improves the conditions required for prompt and satisfactory service. The transverse partitions separating the compartments are 5 ft. 9 in. apart and the compartments are 4 ft. 10 in. wide. The aisles on either side of the compartments are 2 ft. 3 in. wide. The dining room is 45 ft. 1 in. in length.

The floor covering in the dining room is of maroon flexolite, that in the passageway in front of the buffet and end of the car of ¼ in. inlaid rubber, while the kitchen and pantry floors are covered with copper. The lamps in the dining room are all of the semi-indirect type affording ample illumination without unpleasant glare. The cars are 78 ft. 10 in. long, over end posts. They are of steel construction, with interior finish of Cuban mahogany. The Barney & Smith Company built the bodies; the Standard Car Truck Company designed the six-wheel built-up steel trucks.



Interior View of the Erie Dining Car



Floor Plan Showing the Arrangement of Tables in the Center of the Erie Dining Cars

NEW DEVICES

PLAIN GRINDING MACHINES

An interesting application of a multiple friction disk drive is found in the Nos. 10 and 11 plain grinding machines built by the Brown & Sharpe Manufacturing Company, Providence, R. I. Fig. 1 shows a No. 11 machine. These machines have also wheel and work speeds and feeds that are entirely independent, and the drive is self-contained. Power is transmitted through a main driving shaft running in taper roller bearings at the rear of the machine and driven from a simple overhead countershaft.

A large pulley located centrally between the two roller bearings on the main driving shaft drives the wheel spindle with a belt running over two idler pulleys. Changes in wheel speeds are obtained by means of split pulleys on the wheel

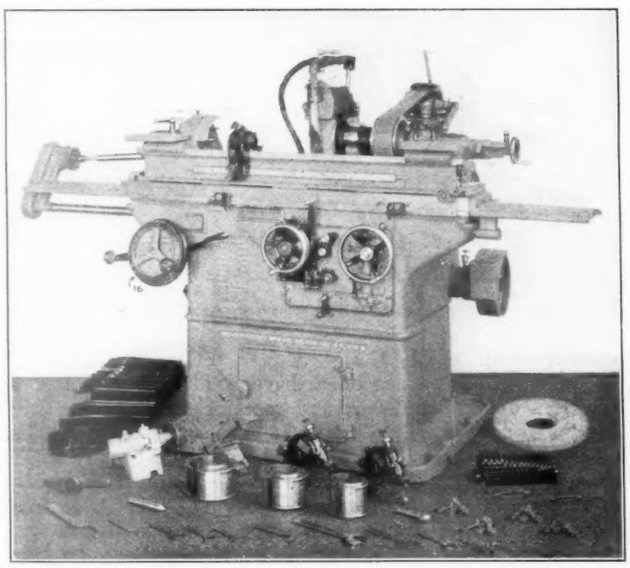


Fig. 1—Brown & Sharpe No. 11 Plain Grinding Machine

spindle which may be quickly interchanged without removing the belt. The idler pulleys run on taper roller bearings supported in a heavy swinging bracket so constructed as to follow the transverse movement of the wheel stand, thus keeping a uniform tension upon the driving belt regardless of the position of the grinding wheel. The slack in the belt due to the difference in diameter of the wheel spindle pulleys when changes in wheel speeds are made, is taken care of by the top idler pulley, which is provided with separate adjustment, making it possible for the operator to place the necessary tension on the wheel spindle driving belt. The work speed and table feed mechanism is built as a unit and is located in a case at the rear of the machine, being coupled directly to the end of the main driving shaft.

Fig. 2 shows the arrangement of the drive for the wheel. Sprocket *A* at the end of the speed and feed case, is connected to the reversing mechanism and drives the table traverse. Driven sprocket *B* is located on the table traverse reversing mechanism, which is built as a unit and fastened into the bed of the machine from the front. The headstock is driven from the speed and feed case by a sprocket *C* to a double sprocket *D*, acting as an idler, to a hardened splined sprocket *E*. A splined shaft *F* supported in bronze bearings under each end of the table and sliding in splined sprocket *E* transmits power to the end of table from whence it is carried to the headstock, through chains and sprockets

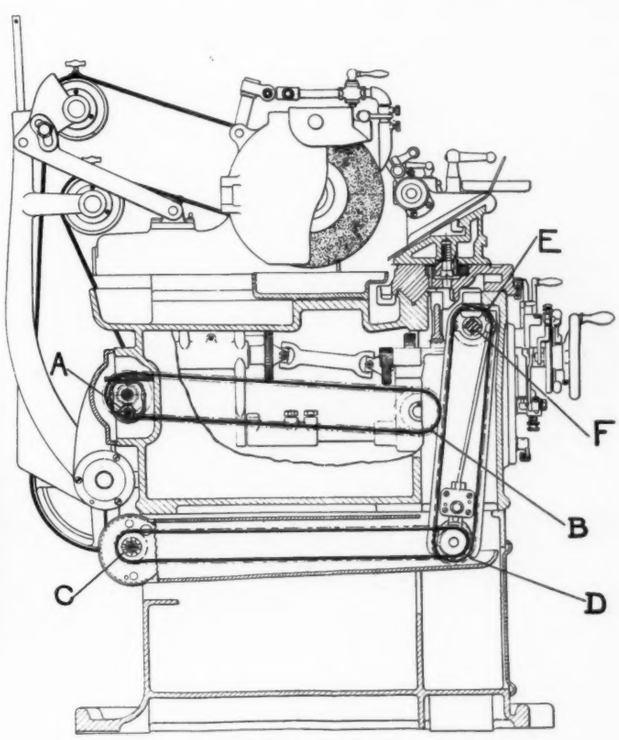


Fig. 2—Driving Mechanism for the Grinding Wheel

and a telescopic shaft with universal joints which permit the headstock to be moved longitudinally and the table to be set at an angle. The splined and telescopic shafts are clearly shown in Fig. 1.

The work driving plate is mounted upon a sprocket running on tapered roller bearings around a fixed spindle which firmly holds a dead centre in such a manner that it practically becomes an integral part of the headstock.

SPEED AND FEED CHANGING MECHANISM

The drive from the main shaft of the machine to the sprockets in the speed case that in turn drive the headstock

and table is of a multiple friction disk type. It enables the operator to start and stop work or table movements without shock and gives practically universal choice of independent speeds and feeds. Fig. 3 shows the interior of the case in which this mechanism is contained. From the shaft *I*, which is coupled to the main driving shaft of the machine, power is transmitted through gears to two separate driving shafts *G* and *H*, running at constant speed. These shafts carry a series of hardened steel disks, ground slightly convex, and each meshing with another series of hardened steel disks. The latter disks have a rim at their periphery, bringing the point of contact always at their extreme edge.

The driving shafts *G* and *H* are mounted in swinging brackets pivoted on the main driving shaft bearings. They are swung toward or from the driven shafts, carrying the driving disks toward or from the centre of the driven disks, thus obtaining the desired changes in the speed of the work or feed of the table by decreasing or increasing the radius of the driving disks. A continuous flow of oil from a pump directly connected to the main driving shaft furnishes lubricant for the entire case.

The control of the speed and feed case is governed by three levers grouped around a dial mounted at the front of the machine. A lever marked "Head" (at the left) serves to operate the set of disks that govern the headstock or work speeds. Twelve indicated changes of work speed and the fine division between these indicated changes are available.

A second lever marked "Table" (at the right) serves likewise to change the rate of table traverse. The corresponding dial is graduated to read in inches per minute. Any desired change from 13 to 181 in. per minute may be obtained.

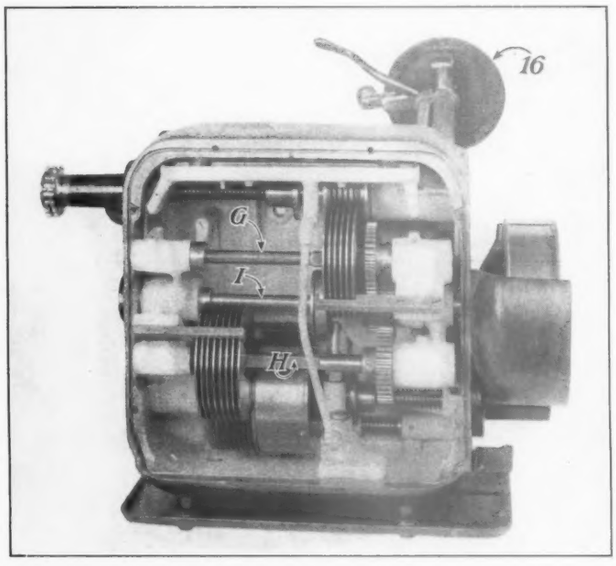


Fig 3—Interior View of Variable Speed Case for the B. & S. Plain Grinding Machine

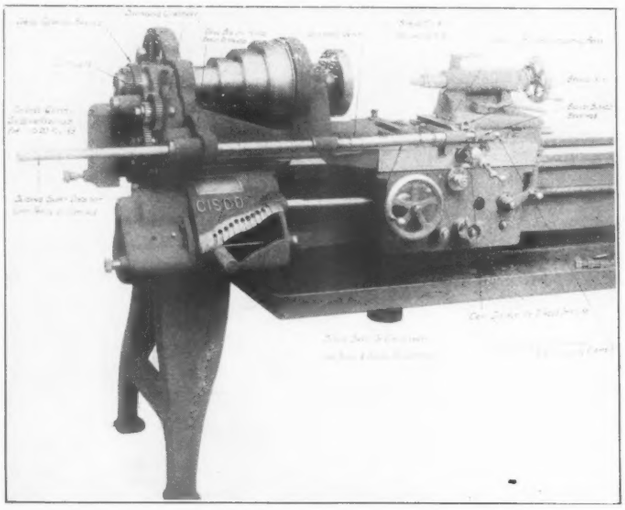
A third and longer lever operates the springs which hold the friction disks firmly in contact and serves to instantly start or stop both work and table simultaneously without stopping the grinding wheel.

INDEPENDENT AUTOMATIC CROSS FEED

These machines are provided with the independent automatic cross feed, which enables the wheel to be fed automatically into the work without traversing the table. This feature is desirable when the portion of work to be ground is not as great as the width of the grinding wheel. This independent automatic cross feed is driven from the table traverse mechanism and operates the ratchet mechanism of the regular automatic cross feed. As a result the full number of changes of feed that can be made with the regular cross feed mechanism are available. These may be increased or decreased by changing the speed of the table traverse mechanism with the table traverse feed change mechanism, giving practically a universal selection of feeds from the coarsest to the finest that are ever required. A positive safety lock prevents table traverse when the independent automatic cross feed is in operation.

"CISCO" RELIEVING ATTACHMENT

The Cincinnati Iron and Steel Company, Cincinnati, Ohio, recently designed a relieving attachment for engine lathes. It is driven from a gear on the outside end of the spindle. This gear replaces the spindle bushing and necessitates no change whatsoever in the spindle itself. It is engaged by an idler which in turn drives the change gears on the swinging quadrant. Six change gears are all that are required to obtain the correct changes for the following



"Cisco" Lathe with Relieving Attachment

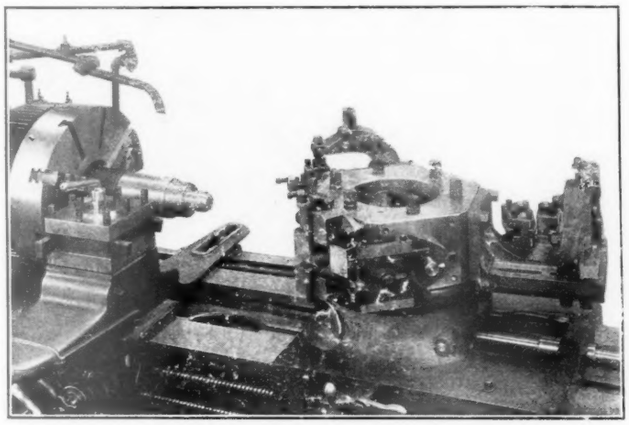
number of flutes: 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20

The quadrant swings on a drive box which is bolted to the front of the head stock and contains the gears for driving the sliding shaft. This shaft is journaled in a bracket on the carriage and the sliding end may be made any length to suit any length of bed, therefore, not limiting the travel or position of the carriage when relieving. The drive from this shaft to the camshaft is through universal joints, a shaft and sleeve. This compensates for slide and swivel adjustments. The swivel can be turned to an angle of 30 deg. and all bottom and top slide adjustments can be made in connection with the relieving attachment exactly the same as in the regular lathe. Relieving can also be done in connection with the taper attachment. The camshaft runs in bronze bearings and is easily removed for placing the cams.

Two cams are provided with each attachment, single and double impulse. The cam operates against a hardened steel roller held in a hardened steel slide, this slide being connected to the top slide screw and has a spring rod with tap adjusting nuts which govern the amount of throw or relief required, or it can be made to hold the slide and roller away from the cam when the compound rest is required for regular work. The change gears are well guarded and an idle plate showing the gear arrangements is furnished. This attachment can be either applied when building the lathe or after the lathe has been built.

LIBBY HIGH POWER TURRET LATHE

The Libby heavy duty turret lathe has been in use in railway shops on heavy bar and chucking work for a number of years. The manufacturers of this machine, the International Machine Tool Company, Indianapolis, Ind., has recently placed on the market a new turret lathe known as type *C*, which represents an improvement over the former design in accuracy and economy of production. In this machine care has been taken to provide ample power and rigidity and also to reduce to a minimum the labor required



Libby Lathe Finishing Crank Pins from Bar Stock

of the operator. It has been used with good results on crank, crosshead and knuckle joint pins, washers and collars, valve rings and similar parts.

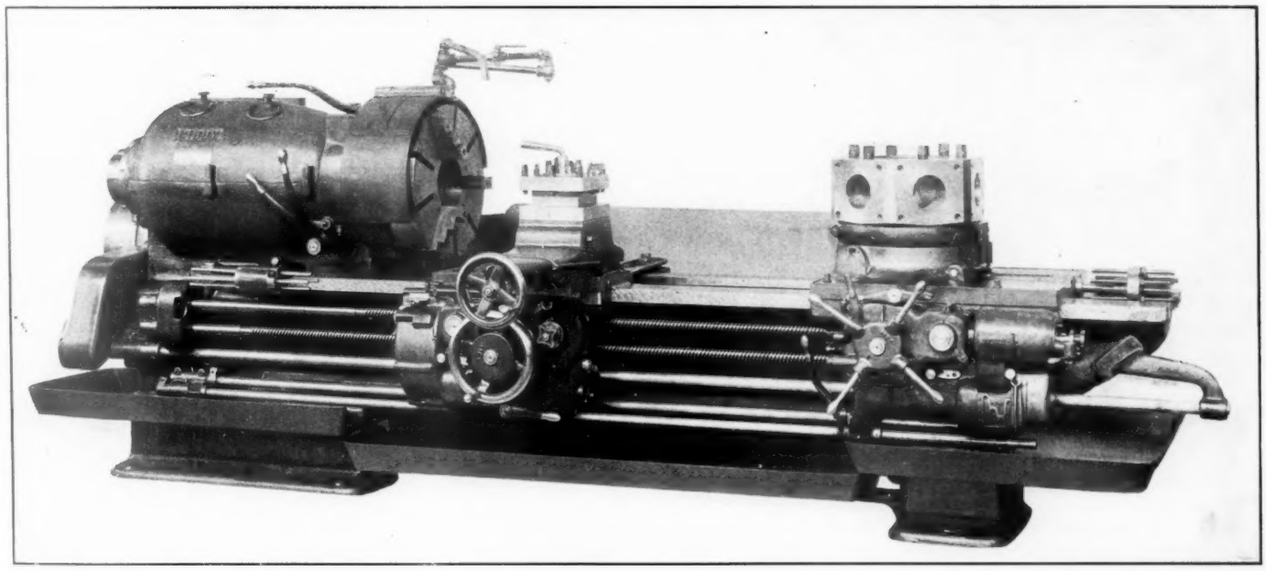
This machine has a swing over the ways of 26 in. and over the carriage of 24 in. with a 7½-in. hole through the spindle. The travel of the carriage is 72 in. As regularly furnished, the lathe carries a 22-in. 3-jaw universal chuck. If desired, a 4-jaw combination chuck or a collet chuck, designed to take bar stock up to 7¼ in. in diameter can be furnished. The bed and the headstock housing are cast in one piece. The bed is cross-ribbed and has a longitudinal rib through the center. The ways are broad and flat and provide extensive bearing surfaces for the carriages. By their positions relative to the spindle they receive the cutting strains direct. The front way is undercut 15 deg. to receive long taper gibs for both the tool post and the turret slides, which take care of the side thrusts of both carriages.

The headstock is of the geared type with single pulley drive. The gears are of wide face and coarse pitch, the material being either steel or semi-steel. The chuck ring gear is 22 in. in diameter, and is keyed and bolted to an 11-in. flange forged on the spindle. The frictions are of large diameter and will carry the full capacity of the belt. The machine can be started and stopped under the heaviest cut without releasing the feed. The spindle is of high carbon steel threaded to receive the chuck, and has a taper seat for centralizing the chuck. Eight spindle speeds ranging from 8 to 142 r.p.m. are provided by the change gears. All spindle and shaft bearings in the headstock are of phosphor bronze. The spindle bearings are adjustable for wear and are provided with ring oilers.

The tool post carriage is of the side carriage type. There is no bearing on the back way, but instead a taper gibbed bearing is provided on the bottom of the front side of the bed. This construction permits the tool post to pass the chuck and allows the turret to come up flush with the chuck so that short, stocky tools can be used. A heavy, four-side, turret type tool post is provided. It can be locked rigidly in any of the four positions and clamped in any intermediate position desired. Stops are provided for each face of the turret and there is also a sight indicator for use in reproducing diameters. Forty-eight feeds are provided ranging from .50 in. to .0078 in. per revolution of the spindle.

The turret slide is of heavy construction, with a long bearing surface on the bed. It is gibbed horizontally and vertically and has a positive clamp to hold it stationary when using centers. The turret is of the hollow hexagon type 18 in. across the flats, with 4½-in. holes. It is mounted on a conical seat and centers by a lock pin. The lever which controls the lock pin also operates the clamp ring which holds the turret in position. There are 80 changes of feed ranging from .50 in. to .0039 in.

A power rapid traverse is provided for both the tool post and turret carriages, each being independent of the other. None of the headstock or feed gears is used in the rapid traverse mechanism. The hand movement of the slides is by means of a hand wheel on the tool post slide and a pilot wheel on the turret slide. One revolution of either wheel advances the slide one inch, which gives sufficient power to



Type C Libby Lathe for Heavy Work

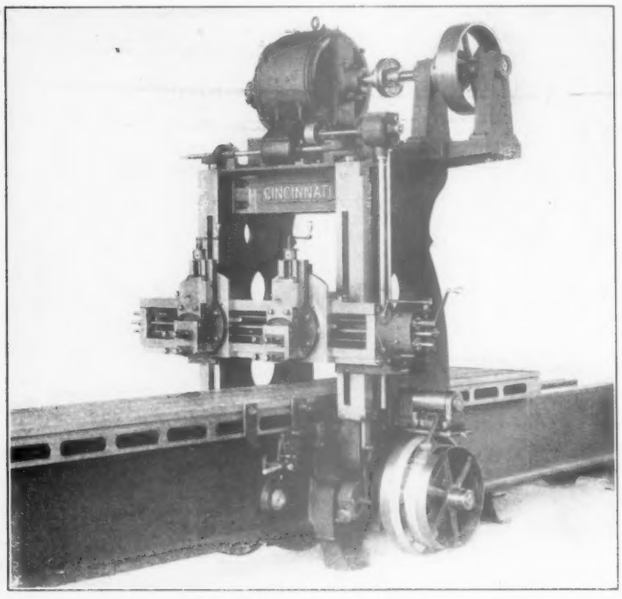
operate the slide while the machine is cutting. Throughout the machine provision for insuring oil reaching any part that requires it has been made. The machine will cut any standard thread from ½-in. lead down, including 11½ threads per inch. Among the special attachments that can be furnished for this machine are oil pans and pump, a taper attachment, bar feed, two-speed countershaft and standard or special tools for chucking or bar work.

The turret lathe is regularly furnished with a countershaft having 18-in. pulleys and designed to run at 360 r. p. m. If it is desired to use motor drive a motor of any make or type, either constant or variable speed, running at from 1,100 to 1,500 r. p. m. and having a capacity of about 20 hp. may be used.

CINCINNATI PLANER

A new design of a 30 in. by 30 in. planer has recently been developed by the Cincinnati Planer Company, Cincinnati, Ohio, in which several interesting features are included.

The bed is of the latest design in which the top between the vees is closed up in the casting excepting at the gearing sections. This makes a strong box section and eliminates danger to the operator. The bed is bored to receive the shaft bearing and all driving gears are inside the bed supported by two bearings, thus eliminating the overhung construction. The loose pulleys are equipped with self-oiling bronze bushings, and the driving pulley is made of aluminum. The shifting mechanism is of a new design in which the cam slots are milled into the outside diameter of a round casting. This cam is supported in a substantial



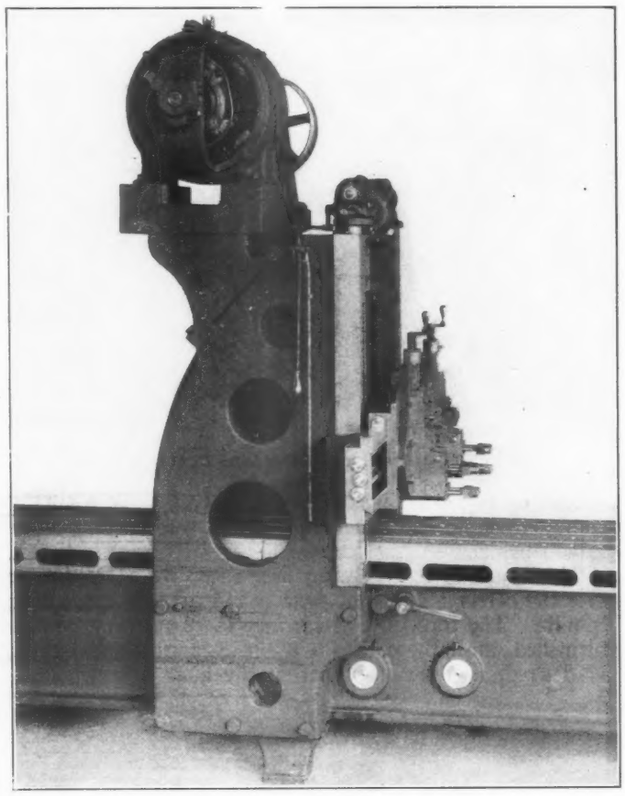
New Design of 30-in. by 30-in. Cincinnati Planer

bracket bolted against the housings, which also provides an extra support to the belt arms. A drip pan is attached to the lower side of the bracket which catches the oil from the shifting device, thus leaving the belts dry.

The table is of box type being closed at the bottom as well as the top. The housings are of box type and are carried to the bottom of the bed. They are fastened to the sides by bolts and dowel pins and are further secured by a tongue and groove arrangement.

The cross rail is of entirely new design. The reinforced arch on the back is made to a true half circle. This section is used so as to provide additional strength for the torsional stress imposed by overhung cutting tools. The saddle is carried up to the full length of the harp. An extra clamp is provided at the extreme end which provides the necessary rigidity. The saddle is taper gibbed at the top and the clapper box is provided with a rectangular shaped clamp instead of the circular clamp arrangement as was provided in the old type.

The machine shown in the photograph is provided with rapid power traverse to the rail heads. It is driven from



Left Side View of the Cincinnati Planer

the top of the machine through a pair of bevel gears and friction clutch which is manipulated from the end of the cross rail and is within easy reach of the operator. It is impossible to engage the feed and rapid traverse at the same time.

The housings are provided with a set of pads onto which the brackets can be fastened for the motor drive arrangement at any time after the machine has been purchased. This machine is regularly equipped with a two-speed countershaft drive giving two cutting speeds and constant reverse.

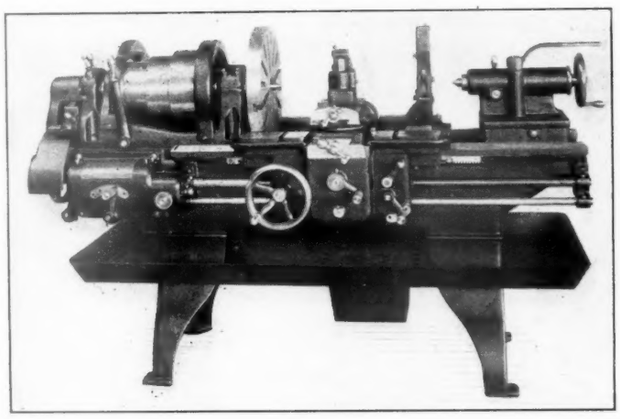
The left side view of the machine shows the automatic limit stop for the elevating device which is an added feature to this machine. This consists of a vertical rod having two collars connected to the shifting levers of the company's standard elevating device. These levers operate the friction clutches at the top of the machine for raising and lowering the rail. A bracket is fastened on to the back of the cross rail through which this rod passes. The collars on the rods are set to a predetermined height and it will be seen that when the bracket on the rail comes in contact with the collars, the vertical rod is moved in either the upward or downward motion causing the levers on the elevating device to operate the friction clutches.

All gears are thoroughly covered for the safety of the operator.

MORRIS STANDARD ENGINE LATHE

The Morris Machine Tool Company, Cincinnati, Ohio, has recently put on the market an 18-in. engine lathe, an illustration of which appears below. This machine has a swing over the ways of 18⅞ in. and over the carriage of 11⅛ in. It is built with beds from 6 to 14 ft. long. The lathe fitted with an 8-ft. bed will handle work 4 ft. 2½ in. long, the length handled by the other sizes being in proportion to the length of beds.

The headstock is strong and well braced. The spindle is of hammered high carbon crucible steel, with 1½-in. diameter hole, fitted with No. 5 Morse taper bushing and No. 4 Morse taper center. It is also threaded to receive a chuck. Either single or double back gearing can be provided. The



Morris 18-in. Engine Lathe

machines with single back gear are fitted with a four step cone pulley for 3¼ in. belt, while those with double back gears have a three step pulley for 3¾-in. belt. The single back gear gives 16 speeds, ranging from 5 to 357 r.p.m., while the double back gears provide 18 speeds, from 13.5 to 346 r.p.m.

The carriage is of unusually heavy construction with bearings 30¾ in. long supported on large vees. The carriage is gibbed to the bed at both the front and back and is fitted to receive a taper attachment. The apron is of a patented one-piece box construction with all bearings cast integral. All gears are of steel and have bearings at both ends of the shafts. Each feed friction is operated by a single lever. An interlock makes it impossible to engage the thread and feed mechanisms at the same time. The standard feed box gives four changes of positive feed. With even gears on the stud and screw, these give 8, 16, 22 and 32 cuts per inch. With the regular equipment a range of threads from 2 to 30, including 11½ threads per inch, can be cut. Provision is made for the use of change gears to cut special pitches or metric threads. A chasing dial is provided for catching threads. A compound rest with a swivel graduated in degrees and clamped by a single bolt is regularly furnished. The tool post will take ⅝ in. by 1¼ in. tools.

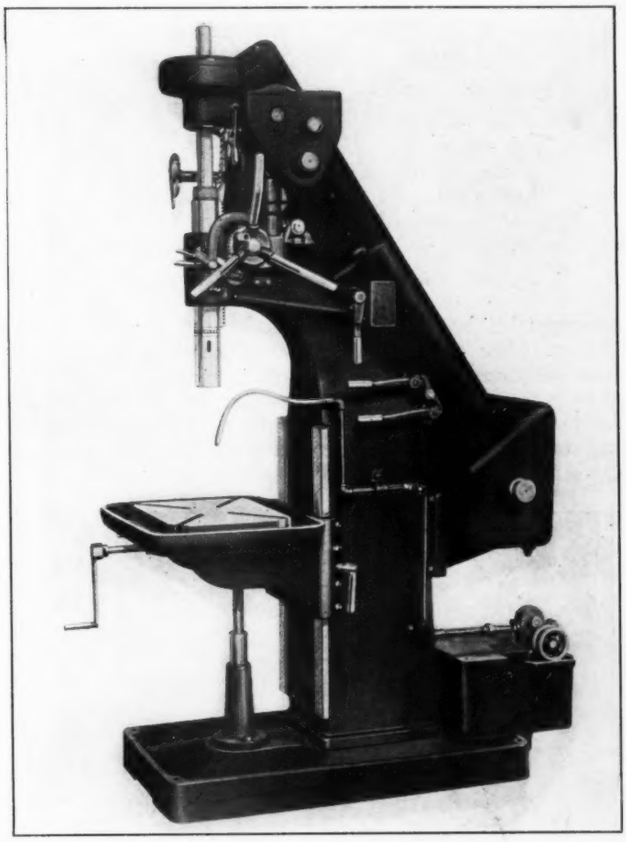
The tailstock is of a heavy box section with the bottom graduated and provided with set over screws. The spindle is of steel and it is clamped by split bushings operated by a single handle. The bed is 16½ in. wide by 13⅜ in. deep, braced with numerous cross girths. It is regularly supported by two legs, but with beds more than 10 ft. long a center leg is also provided.

The countershaft has double friction pulleys 14 in. in diameter for 4-in. belt. For the single back geared lathes the speed of the countershaft should be 120 and 160 r.p.m., while with double back gears it should be 205 and 245 r.p.m. The regular equipment of the lathe includes follow and steady rests, two face plates, wrenches and the countershaft. If desired, extra furnishings including a plain rest, taper attachment, turret on shears, carriage, or tool post, a European tool post, pan and pump can be furnished.

ALL-GEARED DRILL AND TAPPER

The heavy duty all-geared drill and tapper shown in the illustration is manufactured by the Barnes Drill Company, Rockford, Ill. Every bearing in the machine, aside from the spindle sleeve and cross spindles, is self-oiled. There are eight changes of geared speeds and ten changes of geared feeds, all of which are under the immediate control of the operator from the front of the machine. All the gears of the machine are fully enclosed.

Oil is pumped by a geared pump in the reservoir of the machine and distributed to all the gears and bearings, including the crown gears and feed box. The transmission gears are cut from a high grade of chrome-nickel steel, being heat treated and tempered to prevent wear. The machine may be equipped with an automatic reversing mechanism manufactured by this company which can be set so that



Barnes 22-in. All-Geared Drill and Tapper

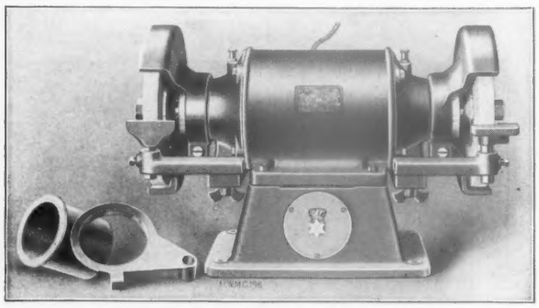
the instant a tap reaches the required depth, the spindle will automatically reverse.

The machine is driven by a 10-h.p. motor for ordinary use, running at a speed of about 1,200 r.p.m. Speeds varying from 28 to 575 r.p.m. are obtained on this machine and the feed varies between .003 in. and .093 in. per revolution of the spindle. The machine will handle a 2-in. high speed drill in solid steel. The distance from the center of the spindle to the face of the column is 11 in. and the maximum distance from the regular table to the nose of the spindle is 32 in. The spindle has a travel of 14 in. and is equipped with either a No. 4 or No. 5 Morse taper, as pre-

ferred. The size of the regular table is 20 in. by 14 in. and has a vertical travel of 23 in. The floor space occupied by this machine is 52 in. by 31 in. It has a net weight of 2,540 lb. with the regular table and 3,200 lb. with the compound table, including the oil pump attachment.

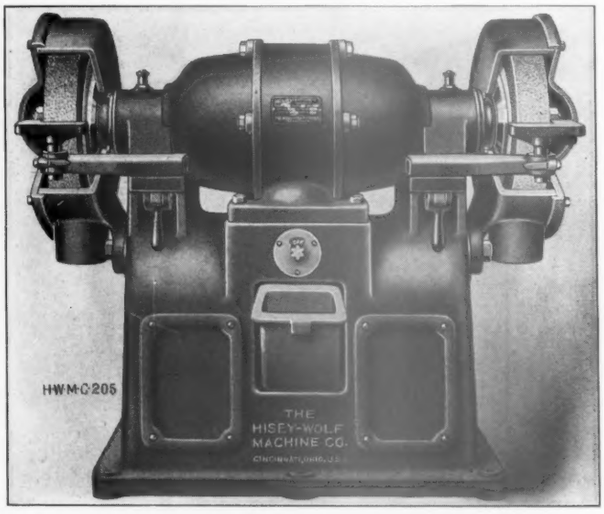
BALL BEARING BENCH AND FLOOR GRINDERS

The bench and floor grinders and buffers shown in the illustrations are made by the Hisey-Wolf Machine Company, Cincinnati, Ohio. They are electrically driven machines, being self-contained in a compact unit. The spindles are made of high-grade steel, accurately ground. They run in S K F ball bearings, mounted in caps in close proximity to the grinding wheels, all the bearings being protected from dust and grit and provided with heavy felt protector washers on each side of the bearing housing. All the wheels are fitted on spindles of standard dimensions



Bench Grinder and Buffer

recommended by the American Society of Mechanical Engineers. The flange washers are of ample size and carefully machined to provide the proper balance. The wheel guards are made of steel and enclose the grinding wheels for three-quarters of the circumference. Direct or alternating current motors are used to drive the machines. In both cases the motors are designed especially for this service, the



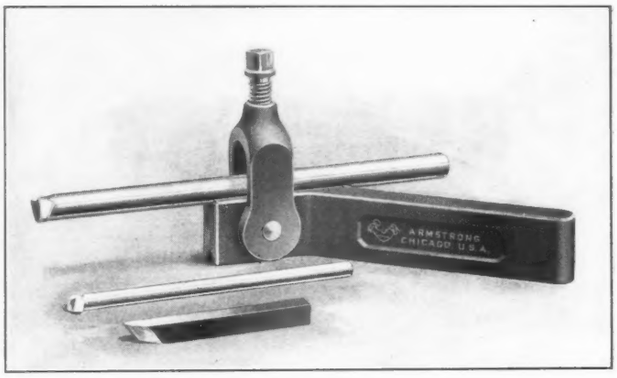
Floor Grinder and Buffer

direct current motors being compound wound and of the shunt type. They are designed to operate at uniform speeds and for continuous service within their capacity. The alternating current motors are of the squirrel cage induction type.

The larger floor grinders have a wheel 18 in. in diameter by 3 in. thick. They operate at speeds of 1,100 r.p.m. and are driven by 5-h.p. motors. The largest bench grinder has a wheel 14 in. in diameter by 2 in. wide, operates at a speed of 1,700 r.p.m. and is driven by a 3-h.p. motor. The smallest bench machine has an 8-in. wheel, ¾ in. thick and operates at 3,400 r.p.m., being driven by a ½-h.p. motor.

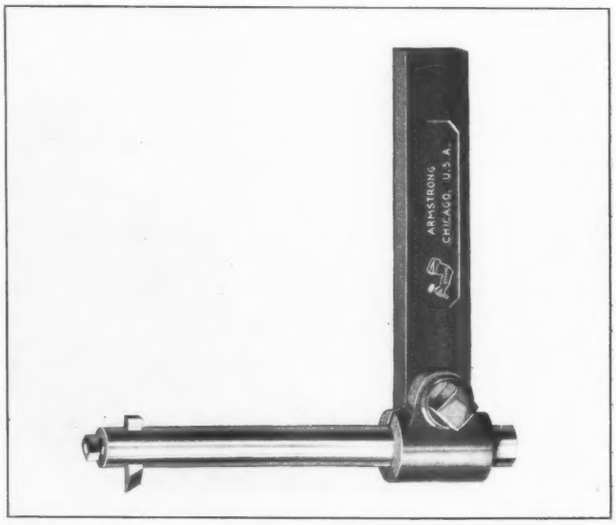
ARMSTRONG TOOL HOLDERS

The Armstrong Brothers Tool Company, Chicago, Ill., has lately developed two new tool holders, one for a light boring and threading tool and the other for an extension shaper tool. The boring tool holder which is shown in one



Light Boring Tool Holder

of the illustrations, is adaptable to tool room work or any boring work of small internal diameter. It can be used for threading, turning brass, etc. The holder is made reversible and can be used for turning either right or left hand. The size of the tool shank varies from ⅜ in. by ¾ in. to ¾ in. by 1½ in. The extension shaper tool holder forms a rigid sup-



Extension Shaper Tool Holder

port for the cutting tool and can be used to good advantage in die work, cutting internal keyways or for any kind of work on a shaper in which extra clearance is needed. The size of the shank for this tool varies from ½ in. by 1⅛ in. to ¾ in. by 1⅝ in.

MORE AMERICAN LOCOMOTIVES FOR CHINA.—Twenty more locomotives of American make have arrived in Wuchang for use on Chinese railways.

AMERICAN FLEXIBLE STAYBOLT

The American Flexible Staybolt Company, Pittsburgh, Pa., has revised its method of manufacture of its flexible staybolts to give greater resisting action to the stresses to which it is subjected in the locomotive firebox. The slot in the body of the staybolt is slotted as before, but the body slot has all edges and ends worked and rounded to eliminate all square or sharp edges. The fillets formerly used in joining the body to the threaded end have been changed to long tapers which give a better flow of the material from the end into the reduced diameter of the body. The entire forming of the body after slotting and working, including

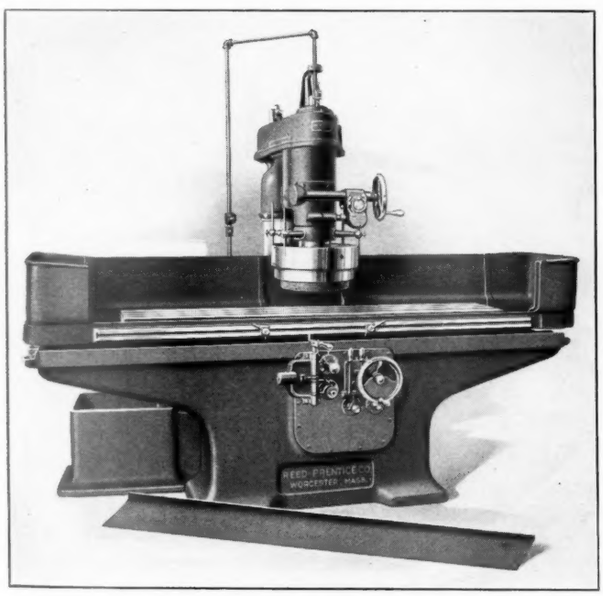
Latest Type of American Flexible Staybolt

the forming of the end tapers, is done by rolling, after which the bolt is twisted and straightened in a press, the square ends for application being formed at that time. All of the forging operations are completed in one heat and the bolts are piled while red hot, for slow cooling before machining.

Laboratory tests have shown that this method of making the bolts has produced a material improvement in their strength and flexibility. The ratio of yield point, or elastic limit to the tensile strength has been shown by tests to be .738, an increase of nine per cent over that generally obtained. The rolling process effects very little change in the original structure of the iron and the outer fibre stresses have been reduced to withstand a maximum lateral vibration.

VERTICAL SURFACE GRINDING MACHINE

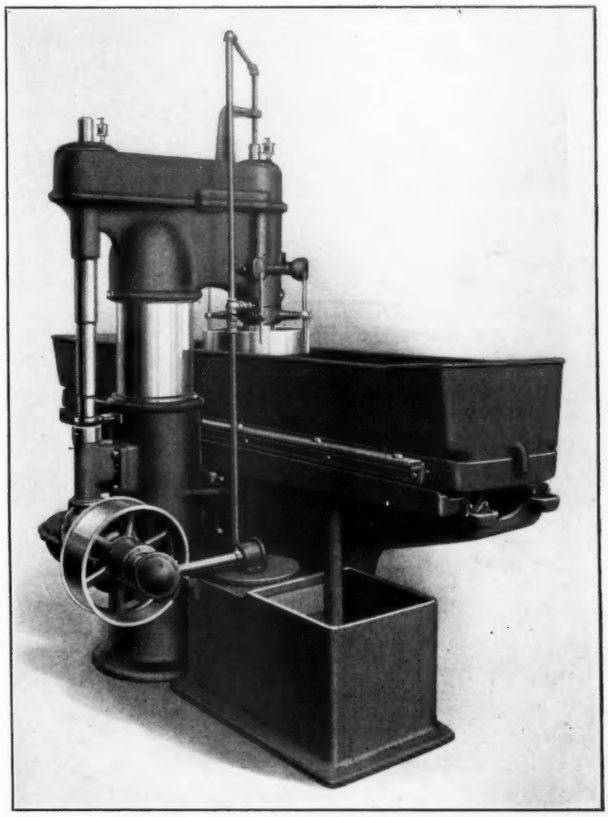
The use of grinding machines is constantly finding wider application to locomotive work. There are a variety of uses to which they may be put and in some instances they have



Reed-Prentice Vertical Grinding Machine

been found to decrease the cost of production and at the same time produce more accurate work. The vertical surface grinding machine shown in the illustration is made by the Reed-Prentice Company, Worcester, Mass. This machine is designed for handling both surface and circular grinding. The head is of rigid construction, it being practically integral with the telescoping column back of the machine. The vertical adjustment of the head may be obtained by either hand or power feed, clamps being provided to hold the head in position after it has been raised to the proper height.

The bearing for the spindle is lined with nickel babbitt and it may be adjusted for wear. The spindle has a bearing of 3 in. in diameter for a length of 8 in. A sprocket and silent chain is used to drive the wheel spindle in preference to belt on account of the moisture and dirt. The spindle is made of alloy steel and is supported at the upper end in a ball bearing, the end play of the spindle being prevented by a heavy coil spring and two ball thrust collars. A



Back View of Reed-Prentice Vertical Surface Grinder

wheel chuck has been provided which will permit the wheels being changed quickly and at the same time hold them firmly. A vertical adjustment of the wheel in the chuck is provided so that the wheel may be used until it has been reduced to ½ in. or less in width without danger of crushing it. The wheel support is of a heavy goose-neck type, the telescoping part of which is supported in the bearings in the base.

The bed of the table is thoroughly braced and ribbed. It has large "V" and flat bearing surfaces. The table is also strongly braced to prevent warping. Six feeds are provided for the table, ranging from 2 ft. to 12½ ft. per minute, or from .021 in. to .142 in. per revolution of the spindle. These feeds are controlled by levers at the front of the base and any feed may be obtained while the machine is in operation. The wheel feed is controlled by either hand or power, a counterbalance being provided. The power feed is provided with an automatic release. Twenty-five feeds may be obtained, ranging from .0002 in. to .005 in.

An ample supply of water is provided to both the inside

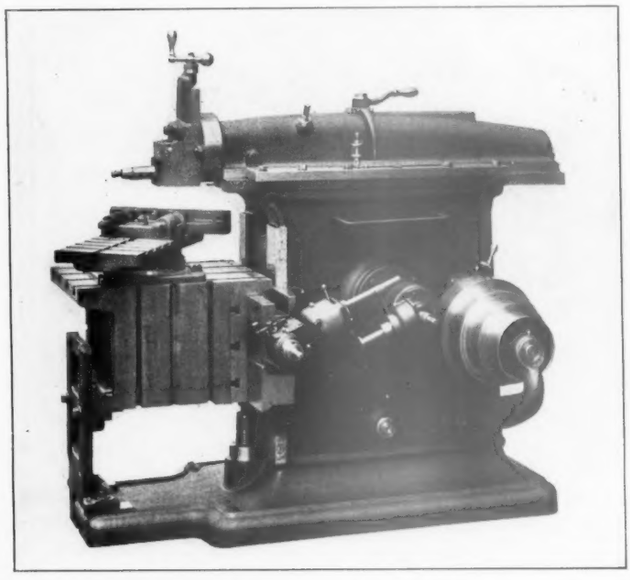
and the outside of the wheel at the same time. The inside supply is furnished through the hollow spindle and the outside is furnished through the ordinary flush system. Rectangular or rotary magnetic chucks are provided with the table as desired. These chucks are waterproof and are well protected from short circuit.

The table has a working surface of 12 in. by 78 in. and a traverse of 78 in. The distance from the top of the table to the underside of the grinding wheel is 15 in. The wheels are 14 in. in diameter, 4 in. wide and have a rim of 1¼ in. The spindle speed is 1,050 r.p.m. The machine occupies a floor space of 5 ft. by 16 ft. 2 in. and has a net weight of 8,700 lb.

BACK GEARED CRANK SHAPER

The 24-in. back geared crank shaper shown in the illustration is made by the Queen City Machine Tool Company, Cincinnati, Ohio. This machine is equipped throughout with helical gears. This type of gear has been adopted by this company on account of the smooth finish of the work produced with them. It has found that they run practically noiseless and without backlash, and although they are cut on a comparatively small helix angle, 14 deg. 15 min., at least three teeth are in mesh at all times, which gives a continuous rolling motion to the ram. All the castings in these machines are either of cast steel or semi-steel. The crank pin and shaft journals are hardened and ground and the bearings are ring-oiled.

The length of the stroke of the ram can be quickly changed and positively locked while the ram is in motion or at rest.

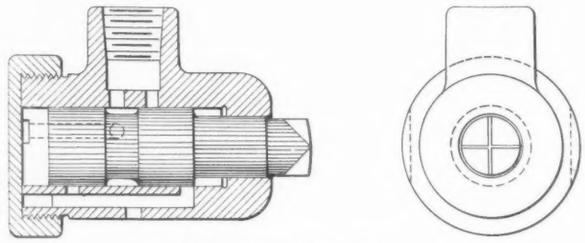


Queen City Back Geared Crank Shaper

All flat bearing surfaces are long and wide with provision for taking up the wear. The crank lug is hardened and ground. The body of the crank pin is a crucible steel casting. The machine is equipped with eight cutting speeds for every change of stroke, ranging in geometrical progression from 6.4 to 92 strokes per minute at 290 r.p.m. Sixteen changes of feed are provided. The table support moves up and down automatically with the rail and is self-alining with the table. It is gibbed closely to the table, eliminating the spring due to both the thrust and lift of the tool when taking heavy cuts. It has a full vertical adjustment and ample bearing on the widest cross traverse. These shapers may be equipped with either an adjustable or constant speed motor.

VALVELESS BOILER SCALER

The George Oldham & Son Company, Frankford, Philadelphia, Pa., has recently placed on the market a valveless boiler scaler which is shown in the sketch. It is a compact little tool of simple construction. Its total weight is only 2¼ lb. and it is 3 in. long and 2 in. wide at the cap

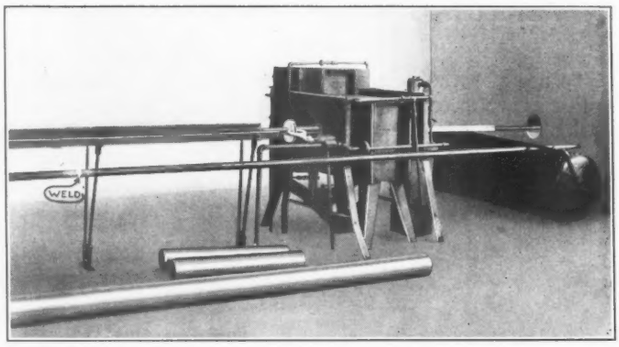


Valveless Boiler Scaler

and 1½ in. wide at the nose end. The stroke is ⅞ in. and the bore of the cylinder is 11/16 in. The tool is small enough to get in at all points of a boiler and can be operated easily by air with an extension pipe.

FLUE RECLAIMING ATTACHMENT

The Draper Manufacturing Company, Port Huron, Mich., has recently developed the flue reclaiming attachment shown in the illustration. This device is used for welding split flues and for welding long sections of flues in connection with the pneumatic flue welding machine manufactured by this company. The welding machine is placed behind the furnace, with the end of a long mandrel central between the dies of the hammer and in line with the center



Draper Flue Reclaiming Attachment

of the furnace. A waterback is placed between the furnace and the welder, through which cold water is circulated to keep the welder cool. The flues to be welded are prepared in the ordinary way. The shorter piece is pushed through the furnace on to the mandrel and the other piece is inserted into or over the lap and the part to be welded is located in the center of the furnace. A clamp is then placed on the flue at a certain distance in front of the welding machine operating lever which is shown at the front of the furnace. The distance between this clamp and the center of the furnace is the same as that between the center of the welder and the operating lever. When the tubes have been raised to a welding heat, they are pushed through on the mandrel under the welding machine. The clamp on the tube will engage the operating lever when the weld is under the hammer of the welding machine, immediately putting the welding machine into operation. In this way, the joint is welded in a very few seconds after it leaves the fire. After the flue has been welded, the clamp is removed and the flue is taken

out and placd on a tilting table, where it is straightened. The tube is then allowed to cool until it will support its own overhanging weight. The only limit to the length of the flue that can be welded is dependent entirely upon the length of the mandrel behind the flue welder. The lengths of flues shown in the illustration are 12 ft. and 14 ft. respectively.

QUICK RELEASING FACE MILLING CUTTER

An inserted tooth face milling cutter which combines quick release and interchangeability with heavy service is manufactured by the Brown & Sharpe Manufacturing Company, Providence, R. I.

Trouble has been experienced at one time or another by machinists in removing the ordinary face milling cutter after it has become heated and "frozen" on the spindle. The

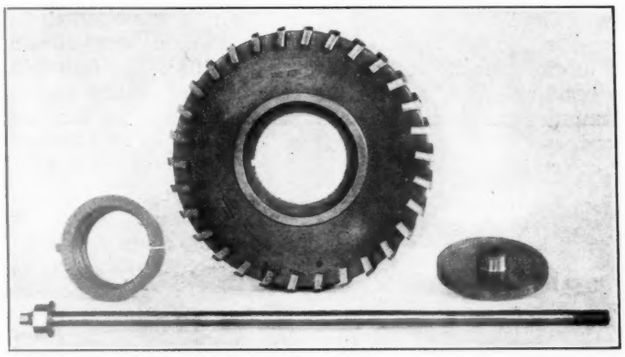


Fig. 1—Brown & Sharpe Quick Releasing Face Milling Cutter

force necessary to get such a cutter off is liable to result in damage to the cutter or may be sufficient to throw the spindle bearings out of alinement. Fig. 1 illustrates a cutter designed to overcome these difficulties, and the sectional diagram, Fig. 2, will show how readily this is accomplished.

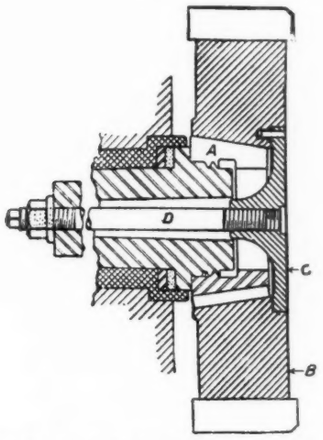


Fig. 2—Section Through Quick Releasing Face Milling Cutter

The split sleeve *A* which has a steep outside taper, screws on the nose of the machine spindle, the cutter *B* with a tapered hole is drawn tightly on this sleeve by the clamping plate *C*, and draw-in bolt *D*. A key in the sleeve fits into the cutter, thus insuring a positive drive.

When the draw-in bolt is loosened, the clamping plate is released, and the steep taper allows the cutter to be slid off instantly. As the cutter is removed, the split sleeve expands and may be unscrewed from the spindle nose very easily. Split sleeves of varying sizes are made to fit different sizes of spindles, thus one cutter may be interchanged from machine to machine, thereby eliminating the necessity of having a set of cutters to fit each machine spindle.

The cutters are held up close to the spindle as there are no long hubs projecting, thus the maximum working space is obtained.

Fig. 3 illustrates the rigid and efficient method used for holding the teeth in the periphery of the machinery steel

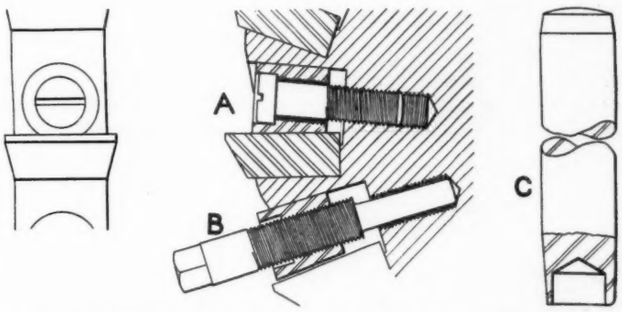


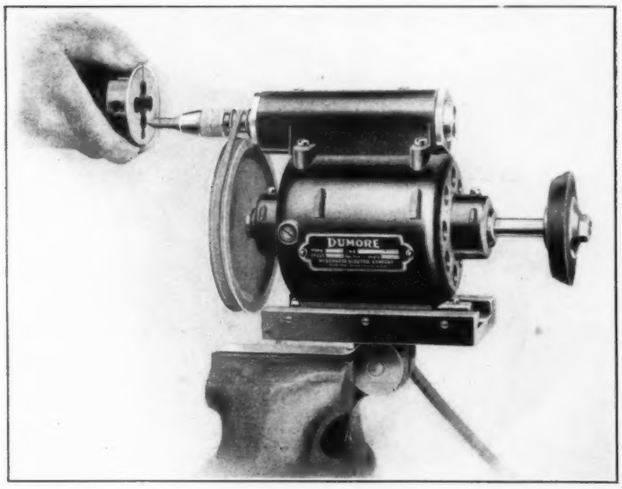
Fig. 3—Method of Holding the Teeth in B. & S. Inserted Tooth Cutters.

body on Brown & Sharpe inserted tooth cutters. When the teeth are inserted, the tapered bushing is driven in place by set *C*, and the screw is then put in, thus firmly securing the bushing. The bushings are removed with the extracting screw *B*.

TYPE "C" DUMORE GRINDER

At the request of a manufacturer who had found difficulty in securing dies on account of the present market conditions the Wisconsin Electric Company, Racine, Wis., made a special grinding machine, which enabled solid dies, round split dies, etc., to be sharpened. The first machine effected such a large saving that the tool has now been added to the company's line of electrical specialties as a special type of the regular Dumore grinder.

The attachment for sharpening solid dies consists of a carborundum pencil, 3/8 in. in diameter, held in a special



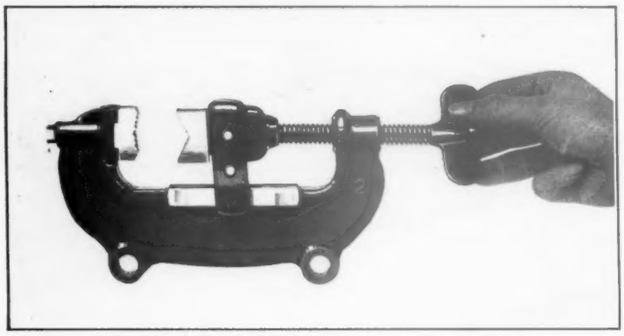
Type C Dumore Grinder

chuck mounted on a spindle which runs at the rate of 50,000 r.p.m. In sharpening dies the pencil is passed through the holes, as shown in the illustration. The teeth of the dies can thus be ground at the proper angle for the most effective work. Pencils dressed to any shape or size desired can be mounted in the chuck. This makes the machine useful

for lapping out blanking dies and for other similar work. Besides the small pencil there is a grinding wheel mounted on the motor spindle, which runs at a speed of 10,000 r.p.m. At shops where the Dumore grinder is already in use the special equipment for grinding dies can be purchased separately and attached to the motor as desired. The device has effected large economies, one manufacturer reporting a saving of from $130 to $200 a month by its use.

A HANDY PIPE VICE

The Whittington-Vaughn Company, Lanesboro, Pa., has recently developed a convenient pipe wrench which weighs less than 4 lb. and will handle a 2-in. pipe. This wrench may be applied at any convenient place by screws or bolts,

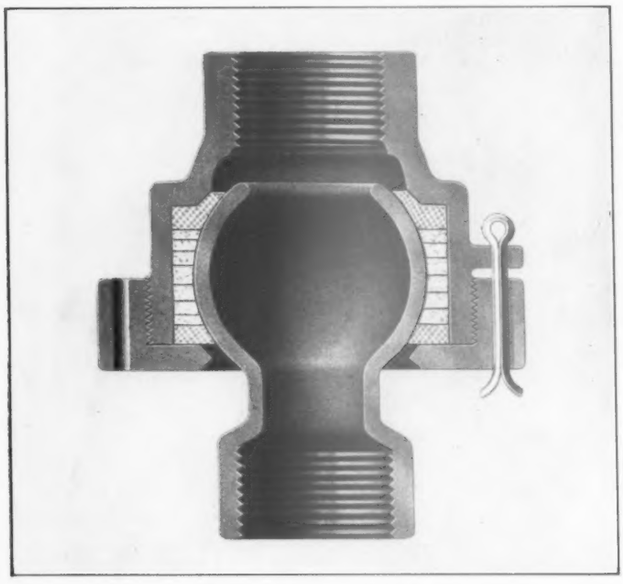


Whittington Pipe Vise

is easily carried in any kit of tools and is of strong construction. The floating jaw is guided on the body of the vise, giving a substantial support to it.

FLEXIBLE PIPE CONNECTION

A flexible pipe connection, consisting of a ball joint packed with ¼-in. braided asbestos, has recently been placed on the market by the Franklin Railway Supply Company, 30 Church St., New York City. It is of simple construction, as shown



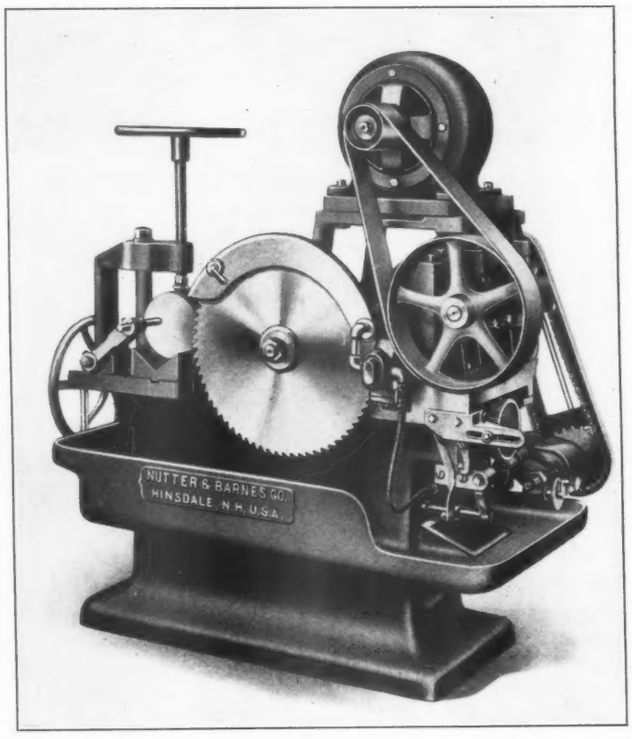
Flexible Pipe Ball Joint

by the illustration. Either the standard square or round asbestos packing may be used to pack the joint. This is of considerable advantage in that no special gaskets are required and the joint can be repacked at any shop or enginehouse. By tightening the packing nuts, the packing is squeezed into place, completely filling the space between the metal rings. The packing nut is prevented from working loose by a cotter pin which extends through a hole in a lug on the body of the joint and a hole on the packing nut.

These flexible joints can be used for both steam and air and with standard piping will replace rubber hose in many places. They are especially adapted for use in roundhouse blower and blow-off lines, terminal coach heating lines, pump testing racks, etc. They can be used also to advantage in the main reservoir connections on locomotives, where flexibility is a desirable feature, and thereby eliminate pipe failures caused by a rigid union joint. The joints are made for either straight or angle connections.

AUTOMATIC METAL CUTTING-OFF MACHINES

The Nutter & Barnes Company, Hinsdale, N. H., has recently improved its cutting-off machines by the addition of a new method of lubrication which provides a heavy stream of lubricant at the cutting edge of the saws. The lubricant is contained in a well in the base of the machine and is pumped from there to a duct which is a part of the saw hood, as shown in the illustration. The supply of lubricant is controlled by the valve at the left of the hood. A flexible



Automatic Cutting-Off Machine

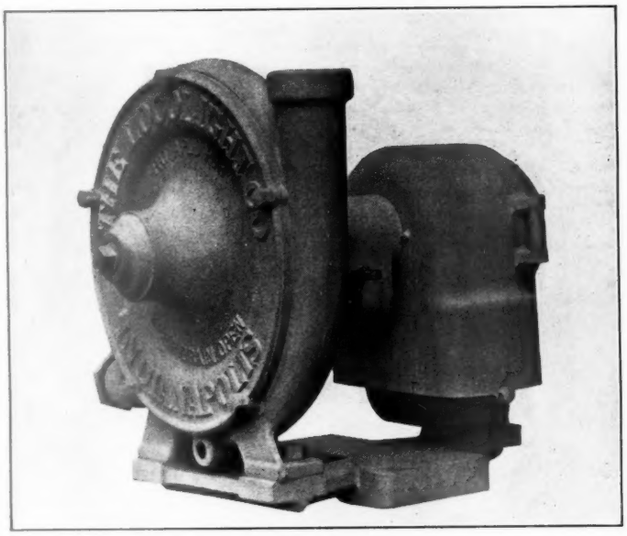
pipe connects the reservoir at the bottom of the machine with the pump.

The motor for driving this machine is mounted directly on the movable slide of the machine. This arrangement is compact and the motor is up off the floor, out of the way of dirt and possible injury. This machine has a work table 14 in. by 23 in. by 29 in. high. The distance between the clamped yoke and the table is 10¾ in. The saw carriage is 23 in. long by 17 in. wide and is equipped with both power and hand feed. The machine is driven by a 3-h.p. motor, has a floor space of 3 ft. by 5 ft. 6 in. and a net weight of 2,800 lb.

LOCOLIGHT HEADLIGHT EQUIPMENT

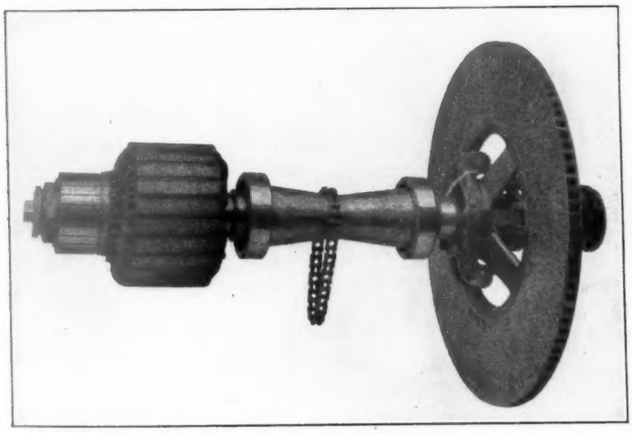
The Locolight Company, Indianapolis, Ind., has recently brought out a new model of the standard generator which the company has been manufacturing since 1914. The new machine, which is rated to deliver 450 watts at 32 volts, embodies all the principal features used in the former type.

The turbo-generator, complete with the base, weighs 109 lb. The length over all is 18½ in., the height 15½ in. and the width 15 in. The turbine wheel is 11 in. in diameter, weighs



Locolight Headlight Generator

about 6 lb., and is designed to run at a speed of 3,200 r.p.m. The governor acts directly on the wheel, the governor weights in action forcing the wheel out of the path of the steam, thus controlling the speed. The shaft, wheel and governor can be removed from the machine without destroying the adjustment of the governor. The shaft is carried on two sets of annular ball-bearings which are lubricated by a chain oiling device. The chain passes over a spacer, between the ball bearings, which is smaller at the center than it is at either



Rotating Parts and Bearings Assembled

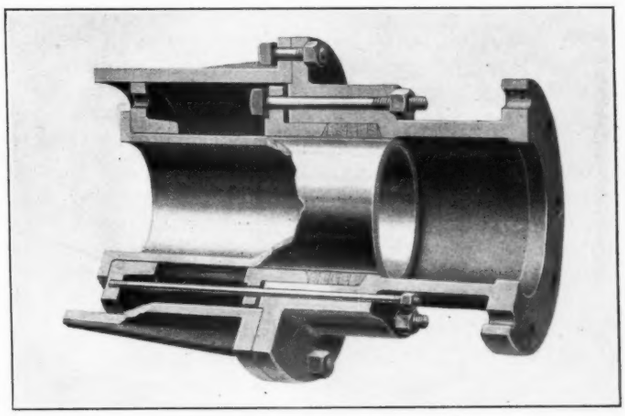
of the ends. The ends of the spacer project into the ball bearing races. The oil which is brought up by the chain is carried by centrifugal force to the ends of the spacer and flies off into the bearings. Spacers at each end of the bearing housing throw off any oil which passes through the bearings and it is carried back to the oil well.

The dynamo is of the Edison bipolar type, compound wound. The field frame is of electric malleable iron with pole pieces and frame in one piece, thus eliminating all joints in the magnetic circuit. The field coils are held rigidly on the frame and are well insulated. The brush holders are of the box type.

The headlight, which is regularly furnished with this generator, is equipped with a 30-volt, 150 watt incandescent lamp, which will comply with the requirements of the locomotive inspection law. The steam consumption of the turbine is approximately 102 lb. of steam per hour at 150 lb. boiler pressure and 128 lb. per hour at 220 lb. pressure. It is claimed for this equipment that the maintenance cost and the consumption of steam and of oil are low and that the absence of grease cups and packing reduces materially the attention which is required at the engine terminals.

EXPANSION JOINT WITH A CROSSHEAD GUIDE

An expansion joint having a crosshead and guide, adapted to all service on high or low pressure water, oil, gas or steam lines, has been tested for several years and is now being manufactured and sold by the Ross Heater & Manufacturing Company, Buffalo, N. Y. It is claimed for this crosshead guided joint that the sleeve is held in perfect alinement and that the weight of the pipe line is relieved from the sleeve and packing, thus preventing excessive wear



Ross Crosshead Guided Expansion Joint

on these parts. The main casting is divided in two parts, which are connected by a heavy flange and bolts. The moving elements consist of a long sleeve made steam-tight by a stuffing box and gland. The sleeve is supported at the outer end by companion flanges, which are machined on the outer surfaces and slide in the guide, the internal surface of which is also machined. Stops are provided on the guide to prevent the crosshead being drawn out of the casing and thus breaking the joint.

All the parts are substantially constructed and are readily accessible by removing the casing. The packing space of the stuffing box is long and is adapted to the use of any kind of metallic or fibrous packing. The sleeve is made of bronze and for pressures up to 150 lb. all other parts are made of semi-steel; for higher pressures cast steel is used. The sleeves are made in two types, one having a free travel of 4 in. and the other of 8 in. These types are made in both single and double joints providing an exceptional range of movement. This joint occupies little space and is easily insulated. It has been used successfully on steam lines carrying a pressure of 175 lb. the steam being superheated to 300 deg. F.

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* L. B. SHERMAN, *Vice-President*
HENRY LEE, *Vice-President and Treasurer* M. H. WIUM, *Secretary*
WOOLWORTH BUILDING, NEW YORK, N. Y.
F. H. THOMPSON, *Business Manager*, CHICAGO.

Chicago: Transportation Bldg. Cleveland: Citizens' Bldg.
Washington: Home Life Bldg.
London: Queen Anne's Chambers, Westminster.

ROY V. WRIGHT, *Editor*
R. E. THAYER, *Managing Editor*
C. B. PECK, *Associate Editor* A. F. STUEBING, *Associate Editor*

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free: United States, Canada and Mexico, $2.00 a year; Foreign Countries (excepting daily editions), $3.00 a year; Single Copy, 25 cents.

WE GUARANTEE, that of this issue 9,750 copies were printed; that of these 9,750 copies 7,885 were mailed to regular paid subscribers, 112 were provided for counter and news companies' sales, 283 were mailed to advertisers, 166 were mailed to exchanges and correspondents, and 1,304 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 54,647, an average of 9,107 copies a month.

The RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The Atchison, Topeka & Santa Fe reports that 263 of its employees from all branches of railway service have already enlisted in the regular army, the national guard, the navy, the marines and the signal, aviation, engineer, and reserve corps.

The Chicago, Burlington & Quincy has granted a 10 per cent increase in pay to all shop men and "unorganized" employees on the road. The increase for the shop and clerical men took effect on May 16, and the track laborers' advance dates back to April 18.

The Interstate Commerce Commission, by an order dated April 12, has extended for eight months from July 1, 1917, the time within which freight cars must be equipped with safety appliances to conform to the standards prescribed by the commission, as set forth in its orders of March 13, 1911, and November 2, 1915.

President H. U. Mudge, of the Denver & Rio Grande, announces that beginning July 1 the company will retire all employees at the age of 70 and will pay pensions to retired employees according to the usual custom on many roads. The pension will be extended to all persons continuously in the employ of the company 25 years and includes both officers and employees. The basis of the pension will be the average monthly pay for the ten years previous to retirement. Of this average pay each employee retired will receive one per cent for each year in the service.

The Texas & Pacific has issued a notice to all of its section and machine shop foremen that they should place in immediate cultivation all the available space along the right of way. In order to provide an adequate supply of labor each section man and machine shop employee is to be given one-half day a week of the company's time to perform this work. The employees will share in the crops thus grown, according to the number of hours the man works, including the one-half day of the company's time allowed, and the extra time that he may put in. Particular attention is to be given to the growing of vegetables, such as tomatoes, cabbage, beans, radishes, potatoes and roasting ears. The planting of cotton is prohibited.

J. M. Hannaford, president of the Northern Pacific, has issued a statement authorizing bonuses for "unorganized" employees, which will aggregate about $750,000. This increase in compensation follows an advance of five per cent made last October, the difference being that the bonus now announced takes in employees whose salaries run up to $3,000 a year, whereas the increase granted last October applied only to those whose salaries were below $2,000. The statement sets forth that in view of the continued increase in the cost of living, employees in service on July 1, 1917, will be granted a bonus of 10 per cent of their wages between January 1 and July 1, except where service has not been continuous and where the wages of employees are fixed by contracts or schedules made by collective agreement. It is further stated that similar bonus payments will be considered from time to time, as conditions warrant.

Preliminary steps for the electrification of the Chicago, Milwaukee & St. Paul from Othello, Wash., to Seattle and Tacoma, are now being taken and construction work will soon be under way. Electric power has been contracted for with the Intermountain Electric Power Company, and substations are to be built at Taunton, Wash.; Doris, Kittitas, Cle Elum, Hyak, Cedar Falls, Renton and Tacoma. These eight stations will be of the same in-door type as was adopted in the recently completed installation between Avery, Idaho, and Harlowton, Mont. The stations will each contain two 2,000 kw. units, and specifications for all the station machinery and locomotives are now in the hands of builders for bids. The poles for the proposed electrified zone have already been bought and are now being delivered. The actual setting of the poles will commence within 30 days. It is expected that the contemplated 225 miles to be electrified from Othello, Wash., to Seattle and Tacoma, will be completed by January 1, 1919, and that the first unit, that between Othello and Cle Elum, will be ready for operation on January 1, 1918.

COMMITTEES TO INVESTIGATE CAR AND LOCOMOTIVE BUILDING CAPACITY

Committees of car and locomotive builders have been organized at the request of the Council of National Defense to investigate the capacity of car and locomotive building plants in this country and the extent of their ability to turn out additional motive power and equipment for the railroads of this country and for the Allies. The membership of these committees is as follows: Car Committee: S. M. Vauclain, vice-president of Baldwin Locomotive Works, chairman; E. F. Carry, president of Haskell & Barker Car Company; Charles S. Gawthrop, vice-president of the American Car & Foundry Company; Clive Runnels, vice-president of the

Pullman Company; R. L. Gordon, vice-president of the Standard Steel Car Company, and A. S. Reeder, vice-president of the Pressed Steel Car Company. Locomotive Committee: S. M. Vauclain, chairman; Andrew Fletcher, president of the American Locomotive Company; H. P. Ayres, vice-president of H. K. Porter Locomotive Company, and Joel Coffin, chairman of Lima Locomotive Corporation.

WOMEN EMPLOYEES IN THE MECHANICAL DEPARTMENT

Following a conference several weeks ago between J. M. Davis, vice-president of operation and maintenance, and officers of his staff, the Baltimore & Ohio announced that positions in its shops, in the freight and passenger terminals and other outside places were open to women. Immediately several applications were accepted. At Lorain, Ohio, where the company handles its largest lake coal and ore traffic, women were given positions in the shops as helpers and at various kinds of light labor. A group of these women shop employees are shown in the photograph which is reproduced herewith.

Women Employed in the Baltimore & Ohio Shops at Lorain, Ohio

The four women shown with overalls are all employed in the shops. The others, from left to right, are employed as oil distributor, blacksmith helper, yard cleaner, car clerk and assorter of small scrap materials. At the time this is written 29 women in all are employed at the Lorain shops. These include 11 laborers and one leading laborer, three car oilers, two blacksmith helpers, two mill laborers, one oil distributer, one janitress, one time checker, one car clerk, one car preparer and five others who are employed at various tasks in the machine and air brake shops. Women have been found to be well adapted to sorting the smaller and lighter classes of scrap material at the Painesville, Ohio, scrap reclamation plant. Women are being paid the same wages as would be paid to men doing the same work.

On the Pennsylvania Railroad every general superintendent has been directed by the general manager, Elisha Lee, to investigate and report, as promptly as possible, in what capacities girls or women can be employed efficiently on all parts of the railroad; what numbers can be so utilized, and to what extent they can perform the work now being done by men. The object of this step is twofold: First, to release men from work that can as well be performed by women, and thus increase the number of male employees available for those forms of railroad service for which women are not so well adapted; second, to prepare for the probability that selective conscription will ultimately result in a considerable depletion of the forces of male employees not actually engaged in the physical operation of the railroad. No men will be dropped from the payrolls to make way for women, although some may be called upon to change the form of their occupation.

Stenography, typewriting and practically all other kinds of clerical work will be open to women at once. This will apply not only at the general offices in Philadelphia, but also at all other offices where large clerical forces are employed, including agencies, freight stations and transfers.

The investigation to be conducted by the general superintendents will also be directed to ascertaining whether or not girls and women may be advantageously employed in other positions, including the lighter forms of machine shop work,

telegraphy, telephony, signaling, ticket selling and car cleaning.

Car and Locomotive Orders in May

As noted elsewhere in this issue the distinguishing feature in the equipment market at present is the continued heavy buying of locomotives. The orders in May were extremely heavy from the standpoint of both domestic and foreign business. The totals for the month were as follows:

	Locomotives	Freight cars	Passenger cars
Domestic	653	4,248	73
Foreign	640	10,000	..
	1,293	14,248	73

Among the important locomotive orders were the following:

Chicago, Burlington & Quincy	45	Mikado	Baldwin
	10	Pacific	Baldwin
	10	Santa Fe	Baldwin
Great Northern	40	Switching	Baldwin
	80	Mikado	Baldwin
Northern Pacific	40	Mikado	American
Pennsylvania	35	Switching	245 Altoona and 30 Baldwin
	81	Passenger	
	129	Mikado	
	23	Decapod	
Pennsylvania Lines West	35	Santa Fe	American
	10	Mallet	Baldwin
	25	Santa Fe	Baldwin
	30	Passenger	Altoona
Philadelphia & Reading	20	Mallet	Baldwin
British War Office	50	0-6-0	Baldwin
Paris-Orleans	50	Mikado	American
Russian Government	250	Decapod	American
	250	Decapod	Baldwin

The freight car orders included the following:

Atchison, Topeka & Santa Fe	1,000	Gondola	Am. C. & F.
Canadian Government	1,000	Box	Can. C. & F.
	1,000	Box	Eastern
Illinois Central	500	Refrigerator	Has. & Bar.
Russian Government	6,500	Box	Am. C. & F.
	3,500	Box	Std. Steel

The Illinois Central's passenger car order accounted for 71 of the 73 passenger cars reported during the month.

MEETINGS AND CONVENTIONS

Master Tinners', Coppersmiths' and Pipefitters' Association.—The annual convention of the American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association for 1917 has been postponed.

American Gear Manufacturers' Association.—The recently organized American Gear Manufacturers' Association held its first convention at the Hotel Schenley, Pittsburgh, Pa., on May 14 and 15. This association has been organized for the purpose of developing, standardizing and improving all products of the gear industry.

Master Boiler Makers' Association.—At a meeting of the executive board in Chicago on Wednesday, May 2, it was decided, on account of war conditions, to postpone indefinitely the eleventh annual convention of the Master Boiler Makers' Association, which was to have been held May 22 to 25 at the Jefferson Hotel, Richmond, Va.

Chief Interchange Car Inspectors' and Car Foremen's Association.—The annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association which was scheduled to be held at St. Louis, Mo., from September 25 to 27, inclusive, has been postponed for one year. The present officers will retain their positions until their successors are duly elected.

Railway Storekeepers' Association.—The annual convention of the Railway Storekeepers' Association, which was to have been held at Chicago, May 21 to 23, has been postponed. In his statement announcing this postponement, President W. A. Summerhays calls attention to the difficulty of securing material at present, and to the importance of storekeepers remaining on their roads to insure that material essential to operation may be available.

Western Railway Club.—At the annual meeting of the Western Railway Club, held on May 21 at the Hotel Sherman, Chicago, the following officers were elected: President, A. R. Kipp, mechanical superintendent Chicago division, Soo Line; first vice-president, A. LaMar, master mechanic, Pennsylvania Lines; second vice-president, G. S. Goodwin, mechanical engineer, Chicago, Rock Island & Pacific; secretary and treasurer, Joseph W. Taylor.

General Foremen's Association.—The executive committee of the International Railway General Foremen's Association has decided that the 1917 convention of that association be canceled. The advance papers will be distributed, however, and the members are requested to send written discussions to the secretary on or before September 15, 1917. These will be incorporated in the regular proceedings, which will be published as heretofore.

Master Mechanics' and Master Car Builders' Association.—At a joint meeting of the executive committees of the American Railway Master Mechanics' Association and the Master Car Builders' Association, held at Chicago on April 30, it was decided not to hold the annual conventions which were to have taken place at Atlantic City, N. J., in June. It was the opinion of the committees that during the war emergency it was imperative for all railway employees to remain at their posts ready to give their best services to their roads and the government.

American Society for Testing Materials.—The twentieth annual meeting of the American Society for Testing Materials will be held at Atlantic City, June 26 to 29, with headquarters at the Hotel Traymore. At the second session on Tuesday afternoon, June 26, a paper will be read by A. T. Goldbeck on "Distribution of Pressure Through Earth Fills."

The other sessions are as follows:

Third session, Tuesday evening, annual address by the president.
Fourth session, Wednesday morning, On Iron and Steel.
Fifth session, Wednesday evening, On Non-Ferrous Metals.
Sixth session, Thursday morning, On Preservative Coatings and Miscellaneous materials.
Seventh session, Thursday evening, On Cement and Concrete.
Eighth session, Friday morning, On Concrete and Lime.
Ninth session, Friday afternoon, On Ceramics.
Tenth session, Friday evening, On Miscellaneous Materials. Committee reports will be presented at this session on Fireproofing, I. H. Woolson, chairman; on Waterproofing, W. A. Aiken, chairman; on Timber, Herman von Schrenk, chairman; Shipping Containers, B. W. Dunn, chairman, etc.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind. Convention postponed.

American Railway Master Mechanics' Association.—J. W. Taylor, Karpen Building, Chicago. Convention postponed.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago. Convention, August 30, 31 and September 1, 1917, Hotel Sherman, Chicago.

American Society for Testing Materials.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Annual meeting June 26-29, Hotel Traymore, Atlantic City, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. R. McMunn, New York Central, Albany, N. Y. Convention postponed.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio. Convention, August 21, 1917, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 547 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1126 W. Broadway, Winona, Minn. Convention postponed.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention postponed.

Master Car Builders' Association.—J. W. Taylor, Karpen Building, Chicago. Convention postponed.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass. Convention, September 11, 1917, Hotel La Salle, Chicago.

Niagara Frontier Car Men's Association.—E. N. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio. Convention postponed.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

W. J. BENNETT, master mechanic of the Utah lines of the Denver & Rio Grande at Salt Lake City, Utah, has been appointed assistant superintendent of the motive power and car departments, with headquarters at Denver, Colo.

G. A. MORIARTY, general master mechanic of the New York, New Haven & Hartford, has been promoted to the newly created position of mechanical superintendent of the lines east, with headquarters at Boston, Mass. Mr. Moriarty began railway work in 1887 as a machinist apprentice on the Baltimore & Ohio. He subsequently served on several different roads as machinist, and then returned to the service of the Baltimore & Ohio as machine shop foreman. He was later with the Erie, and served in different positions on the road. In 1907 he went to the New York, New Haven & Hartford as master mechanic, and in January, 1917, was appointed general master mechanic, which position he held at the time of his recent appointment as mechanical superintendent of the lines east.

G. A. Moriarty

J. L. CUNNINGHAM, master mechanic of the Philadelphia division of the Pennsylvania Railroad at Harrisburg, Pa., has been appointed superintendent of motive power of the Western Pennsylvania division with office at Pittsburgh, Pa. Mr. Cunningham was born on September 28, 1874, at West Fairfield, Pa., and entered the service of the Pennsylvania Railroad on November 13, 1891, as an apprentice in the Altoona machine shop. He was made machinist on February 1, 1896, and in August of that year resigned from the service. In June, 1900, he returned to the service of the Pennsylvania Railroad as machinist in the Altoona machine shop, and the following month was transferred as inspector to the Philadelphia division. On March 1, 1901, he was transferred to the Pittsburgh division in the same capacity and in December, 1902, was made foreman on the Bedford division. One year later he was appointed assistant master mechanic on the Philadelphia division. In January, 1904, he became general foreman, and in August, 1906, was appointed assistant engineer of the Central division. He was promoted to master mechanic of the Maryland division on July 1, 1913, and three years later was transferred to the Philadelphia division in the same capacity, which position he held at the time of his recent appointment.

J. L. Cunningham

BEN JOHNSON, locomotive superintendent of the United Railways of Havana, the Havana Central and the Western Railways of Havana at Cienaga, Havana, Cuba, resigned on May 1. Mr. Johnson is retiring from active business life.

ARTHUR KROHN has been appointed assistant superintendent of motive power of the Missouri, Kansas & Texas, with headquarters at Parsons, Kans.

A. N. LUCAS, general foreman of the locomotive department of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., has been appointed assistant superintendent of motive power with headquarters at Milwaukee.

H. H. MAXFIELD, superintendent of motive power of of the Western Pennsylvania division of the Pennsylvania Railroad, has been appointed superintendent of motive power of the New Jersey division with office at New York, succeeding D. M. Perine. Mr. Maxfield was born in 1873 and was educated at Stevens Institute. He entered the service of the Pennsylvania Railroad on September 5, 1885, as an apprentice in the Meadow shops and on August 1, 1899, he became machinist and in March, 1900, inspector and gang leader. He was promoted in December, 1902, to assistant master mechanic at the Pavonia shops of the Trenton division and in April, 1903, was appointed assistant engineer of motive power of the New Jersey division at Jersey City. On April 1, 1905, he was appointed master mechanic of the Trenton division and in July, 1911, was transferred to the Pittsburgh division in the same capacity. On May 1, 1916, he was promoted to superintendent of motive power of the Western Pennsylvania division and now becomes superintendent of motive power of the New Jersey division.

H. H. Maxfield

JAMES MILLIKEN, superintendent of motive power of the Philadelphia, Baltimore & Washington at Wilmington, Del., has been promoted to special engineer in the office of the general superintendent of motive power of the Pennsylvania Railroad, lines east of Pittsburgh and Erie, with office at Altoona, Pa. Mr. Milliken was born on February 19, 1865, in Newtown, Bucks county, Pa. He was educated in the Philadelphia schools and also took a partial course at the University of Pennsylvania. On September 6, 1885, he entered the service of the Pennsylvania Railroad as a fireman on the Pittsburgh division and in March of the following year was transferred as an apprentice to the Altoona machine shop. After serving his apprenticeship he became assistant road foreman of engines on the Philadelphia and Pittsburgh divisions. In February, 1892, he was appointed assistant master mechanic at the Altoona machine shops; in 1895 he was appointed assistant engineer of motive power of the Philadelphia, Baltimore & Washington, and later served in a like capacity on the New Jersey division. He was appointed master mechanic at the Mount Vernon shops,

Baltimore, Md., in August, 1900, and was promoted to superintendent of motive power of the Philadelphia, Baltimore & Washington in January, 1903.

C. D. Young, engineer of tests of the Pennsylvania Railroad at Altoona, has been appointed superintendent of motive power of the Philadelphia, Baltimore & Washington, with headquarters at Wilmington, Del., succeeding James Milliken. Mr. Young was born on May 19, 1878, at Washington, D. C., and on June 25, 1900, entered the service of the Pittsburgh, Cincinnati, Chicago & St. Louis as a special apprentice. In July, 1903, he was promoted to erecting gang foreman, an on October 16, 1903, he became machine foreman. He was promoted to assistant motive power inspector on January 1, 1905, serving in that capacity until May 1, 1906, when he was transferred to the Pittsburgh, Fort Wayne & Chicago as assistant master mechanic. In September, 1906, he returned to the Pittsburgh, Cincinnati, Chicago & St. Louis as assistant engineer of motive power, and on June 1, 1910, assumed that office under the general superintendent of motive power of the Pennsylvania Lines West of Pittsburgh. On October 1, 1911, he became engineer of tests on the staff of the general superintendent of motive power of the lines east.

C. D. Young

David M. Perine, superintendent of motive power of the Pennsylvania Railroad at New York, has been promoted to the personal staff of the general superintendent of the New Jersey division, with office at New York. Mr. Perine was born February 13, 1869, at Baltimore, Md., and was educated in the schools of his native town. He also took a full course in mechanical drawing and designing at the Maryland Institute. On May 14, 1888, he entered the service of the Pennsylvania Railroad as an apprentice at the Mount Vernon shops of the Northern Central, and completed his apprenticeship at the Altoona shops. In April, 1894, he was appointed assistant road foreman of engines on the Pittsburgh division, and on August 1, 1895, was promoted to assistant master mechanic of the Altoona machine shops. In March, 1899, he was appointed assistant engineer of motive power of the Northern Central and the Philadelphia & Erie, and in March, 1900, was transferred to Altoona as assistant engineer of motive power. He was promoted to master mechanic of the Pittsburgh division on October 1, 1901, and on August 1, 1903, was transferred to West Philadelphia as master mechanic of the West Philadelphia shops. On April 1, 1906, he was prompted to superintendent of motive power of the Northern Central and the Philadelphia & Erie, and on April 1, 1907, was transferred to Pittsburgh as superintendent of motive power of the Western Pennsylvania division. On January 1, 1912, he was transferred to New York as superintendent of motive power of the New Jersey Division, and the West Jersey & Seashore, which position he held until his recent promotion.

D. M. Perine

C. J. Stewart, who has been appointed to the recently created position of mechanical superintendent of the New York, New Haven & Hartford, lines west, with headquarters at New Haven, Conn., began railway work with the Erie as a caller. He subsequently served consecutively as engine despatcher, special apprentice, fireman, engine inspector and foreman on the same road. He then entered the service of the Delaware, Lackawanna & Western as machinist, and later served as foreman and general foreman until 1905, when he went to the Central New England as master mechanic. In 1913 he was appointed assistant mechanical superintendent of the New York, New Haven & Hartford, at New Haven, Conn., which position he held at the time of his recent appointment as mechanical superintendent.

C. J. Stewart

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

A. L. Brown has been appointed master mechanic of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., succeeding F. P. Pfahler.

Thomas C. Donaldson has been appointed master mechanic of the Rochester and Buffalo division of the Buffalo, Rochester & Pittsburgh, with headquarters at Salamanca, N. Y.

T. Hambly has been appointed acting master mechanic of the Canadian Pacific, Algoma district, with headquarters at North Bay, Ont., succeeding J. H. Mills, resigned.

E. J. Harris, superintendent of shops of the Denver & Rio Grande, at Salt Lake City, has been appointed master mechanic of the Utah lines, with headquarters at Salt Lake City, succeeding W. J. Bennett.

O. E. Maxwell has been appointed road foreman of engines of the Pennsylvania Lines at Ft. Wayne, Ind., succeeding J. H. Hanna, transferred.

W. G. McPherson, general roundhouse foreman of the Canadian Pacific at Moose Jaw, Sask., has been appointed division master mechanic at Regina, Sask., succeeding S. W. Falkins, transferred.

Dwight C. Morgan, Jr., has been appointed mechanical engineer of the Pittsburgh & Shawmut, with headquarters at Brookville, Pa.

William E. O'Brien has been appointed road foreman of engines of the Buffalo, Rochester & Pittsburgh, with headquarters at Rochester, N. Y.

F. P. PFAHLER, master mechanic of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been appointed master mechanic at Cumberland, Md., succeeding R. B. Stout.

G. A. SCHMOLL, general master mechanic of the Baltimore & Ohio at Pittsburgh, Pa., has been granted leave of absence on account of ill-health.

W. WELLS has been appointed division master mechanic of the Sudbury division of the Canadian Pacific, with headquarters at Sudbury, Ont., succeeding T. Hambly, transferred.

C. F. WINN, master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has resigned.

CHARLES L. MCILVAINE, master mechanic of the New York, Philadelphia & Norfolk at Cape Charles, Va., has been appointed master mechanic of the Philadelphia division of the Pennsylvania Railroad, to succeed J. L. Cunningham. Mr. McIlvaine was born in Wilmington, Del., on September 25, 1872. He received his early education in the public schools of Wilmington and Philadelphia and later graduated from the mechanical engineering department of the University of Pennsylvania. On October 1, 1899, he entered the service of the Pennsylvania Railroad as an apprentice in the shops at Wilmington and was afterwards transferred to the Altoona shops. He was promoted to draftsman in the office of the superintendent of motive power at Jersey City, N. J., in January, 1903, and was advanced to motive power inspector in February, 1905. In May, 1905, he was appointed assistant master mechanic at the Pavonia shops at Camden, N. J., on May 1, 1907, assistant engineer of motive power at Buffalo, N. Y., and on May 1, 1911, was transferred to the office of the general superintendent of motive power at Altoona, Pa., in the same capacity. On July 1, 1913, he was appointed master mechanic of the New York, Philadelphia & Norfolk at Cape Charles, Va., holding that office until May 9, 1917.

C. L. McIlvaine

CAR DEPARTMENT

S. W. CATON, general car inspector of the Western Maryland at Hagerstown, Md., has been promoted to master car builder with headquarters at Hagerstown.

SHOP AND ENGINEHOUSE

W. T. ABINGTON has been appointed superintendent of shops of the Denver & Rio Grande, with office at Salt Lake City, Utah, succeeding E. J. Harris, promoted.

PAUL BISCHELD has been appointed district foreman of the Union Pacific, at Salina, Kan., succeeding J. A. Brice.

E. J. BRENNAN, shop superintendent of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been promoted to general master mechanic with headquarters at Pittsburgh, succeeding G. A. Schmoll.

F. G. FLESHER has been appointed locomotive foreman of the Canadian Northern at Lucerne, B. C., succeeding T. C. Young, transferred.

W. G. HALL has been appointed shop superintendent of the International & Great Northern, with office at Palestine, Texas, succeeding W. A. Brule, promoted.

JOHN LEE, formerly locomotive draftsman at the Winnipeg shops of the Canadian Pacific, has been appointed shop engineer at that point.

H. A. LYDDON has been appointed superintendent of shops of the Northern Pacific, with office at South Tacoma, Wash., succeeding F. W. Malott, retired from active service.

F. OSBOURNE has been appointed millwright foreman at the Winnipeg shops of the Canadian Pacific.

W. W. SCOTT has been appointed shop superintendent of the Buffalo, Rochester & Pittsburgh, with office at Punxsutawney, Pa.

R. B. STOUT, master mechanic of the Baltimore & Ohio at Cumberland, Md., has been appointed shop superintendent at Glenwood, Pittsburgh, Pa., succeeding E. J. Brennan.

T. C. YOUNG, locomotive foreman of the Canadian Northern at Lucerne, B. C., has been appointed locomotive foreman at Port Mann, B. C., succeeding W. M. Armstrong, who has enlisted for active military service.

PURCHASING AND STOREKEEPING

WILLIAM S. MOREHEAD has been appointed assistant general storekeeper of the Illinois Central, with office at Chicago, Ill., succeeding William Davidson, promoted. He will have jurisdiction over the northern lines.

WILLIAM DAVIDSON, assistant general storekeeper of the Illinois Central at Chicago, has been appointed general storekeeper, with office at Burnside (Chicago). He was born at Selma, Ala., and after leaving school served an apprenticeship in steam and gas fitting, for two years, being employed by the United Gas & Improvement Company, Vicksburg, Miss. In 1893, he entered railway service with the Yazoo & Mississippi Valley at Vicksburg as a car repairer, later serving consecutively as master car builder and wheel clerk, stockkeeper, file clerk, assistant timekeeper, general timekeeper, accountant, storekeeper and assistant chief clerk to the master mechanic. In June, 1908, he was appointed division storekeeper at Vicksburg, and in May, 1910, was promoted to assistant general storekeeper of the Illinois Central and the Yazoo & Mississippi Valley at Burnside (Chicago).

W. Davidson

THOMAS H. RYAN has been appointed purchasing agent of the Alabama & Vicksburg and the Vicksburg, Shreveport & Pacific, with office at New Orleans, La. He was born at New Orleans on March 31, 1886. He entered railway service on July 7, 1903, as a stenographer in the general passenger department of the New Orleans & Northeastern, the Alabama & Vicksburg and the Vicksburg, Shreveport & Pacific. From December, 1905, to April, 1909, he was traveling secretary to the president and general manager of these three companies, and from April, 1909, to May, 1917, he was chief clerk in the purchasing department, which position he continued to fill up to the time of his appointment, as noted

above. He succeeds W. J. Kelliher, resigned to enter other business.

W. A. Summerhays, general storekeeper of the Illinois Central at Burnside Shops, Ill., has been appointed assistant purchasing agent of the Illinois Central and the Yazoo & Mississippi Valley, with headquarters at Chicago. Mr. Summerhays was educated in the Chicago public schools and the University of Illinois. In June, 1898, he entered the service of the Illinois Central as an engineering apprentice assigned to track work, and in 1900 he became section foreman. The following year he was appointed general foreman of construction and later in the same year became assistant general storekeeper. In May, 1910, he was appointed general storekeeper of the same road, which position he held at the time of his recent appointment as assistant purchasing agent.

W. A. Summerhays

H. P. Shanks, assistant purchasing agent of the Louisville & Nashville at Louisville, Ky., has been appointed purchasing agent, succeeding J. P. Harrison, resigned.

Ernest Baxter has been appointed general storekeeper of the Wabash, with office at St. Louis, Mo., succeeding A. J. Sewing, assigned to other duties. Mr. Baxter was born at Delmer, Ont., on October 11, 1882. He began railway work with the Michigan Central in March, 1903, as a messenger in the local freight office, and in May, 1903, was employed by the Algoma Central & Hudson Bay at Sault Ste. Marie, Ont., in a similar capacity. In October, 1903, he was appointed secretary to the superintendent of the Grand Trunk at London, Ont., and in April, 1905, entered the operating department of the Cincinnati, Hamilton & Dayton at Indianapolis, Ind., and later that of the Missouri Pacific at St. Louis, Mo. He was appointed secretary to the general manager of the St. Louis Southwestern at St. Louis in February, 1906, and in May, 1909, was promoted to chief clerk to the president. From June, 1914, to February, 1916, he was purchasing agent of this same company, and from March 1, 1917, to April 30, 1917, was a service inspector for the Wabash at St. Louis, which position he held at the time of his appointment, noted above. He will report to J. E. Taussig, vice-president, at St. Louis.

E. Baxter

John G. Warnecke has been appointed division storekeeper of the Illinois Central, at Centralia, Ill., succeeding G. W. Rice.

OBITUARY

John Heath, formerly master mechanic on the Wisconsin division of the Chicago & North Western, died at his home in Winnetka, Ill., on May 1.

Roscoe B. Kendig, chief mechanical engineer of the New York Central Railroad, with headquarters at Grand Central Terminal, New York, died suddenly on May 10, in Detroit, Mich., while attending a conference with officers of the Michigan Central Railroad. Mr. Kendig was born on March 3, 1868, at Renovo, Pa., and was educated in the public schools of his native town. He began railway work in 1884 as a messenger boy on the Pennsylvania Railroad. From May, 1885, to August, 1890, he served as machinist apprentice at Renovo, and then to January, 1893, as draftsman at the same place. He was then for seven years draftsman in the office of the superintendent of motive power of the same road, at Williamsport. On January 17, 1900, he was appointed chief draftsman of the Lake Shore & Michigan Southern at Cleveland, Ohio, and from March, 1904, to June, 1910, he was mechanical engineer of the same road. In June, 1910, he was appointed general mechanical engineer of the New York Central Lines, and in May, 1912, became chief mechanical engineer of the New York Central Railroad.

R. B. Kendig

Albert E. Manchester, general superintendent of motive power, Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., died at his home in that city May 4, aged 70 years. He was born February 12, 1847, at Beaver Dam, Wis., and entered railway service in 1864 as an apprentice in the mechanical department of the Chicago, Milwaukee & St. Paul. Consecutively he was for five years a machinist at Milwaukee, for 17 years a roundhouse foreman at various points along the line, for two years general foreman of the locomotive department, and for four years division master mechanic for the southwest district, including both car and locomotive departments. On April 1, 1893, he was appointed assistant superintendent of motive power for this company, and on June 15, 1901, was promoted to superintendent of motive power, with jurisdiction over the entire system. In recognition of his long and faithful service, extending over a period of more than 50 years, he was recently promoted to general superintendent of motive power. Mr. Manchester was an active member of the M. M. and M. C. B. associations for 23 years.

A. E. Manchester

SUPPLY TRADE NOTES

McCord & Co., of Chicago, has moved its New York office from 50 Church street to 165 Broadway.

The Okonite Company, Chicago, has moved its New York office to the Astor Trust building, 501 Fifth avenue.

J. T. Luscombe has been elected vice-president and general manager of the Paxton-Mitchell Company, Omaha, Neb.

The Goodwin Car Company has removed its Chicago office from 10 South La Salle street to 10 East Jackson Boulevard.

The Barry Equipment Company, Chicago, Ill., announces that it has changed its corporate name to the Barry Company, Limited.

Robert Radford, for many years secretary and treasurer of the Standard Steel Works Company, Philadelphia, Pa., has been elected also president of the Southwark Foundry & Machine Company, Philadelphia. Mr. Radford was graduated from Girard College in 1894, and soon after went with the Baldwin Locomotive Works. In 1906 he was transferred to the Standard Steel Works in substantially the same position he now occupies, and which he will continue to fill in addition to the presidency of the Southwark Foundry & Machine Company. Much of the success of recent years of the Standard Steel Works Company has been due to Mr. Radford's tireless and well-directed energy. He is thus well fitted for his new executive work.

R. Radford

John W. Dix, asistant general manager of sales and structural engineer of the Carnegie Steel Company, died at Atlantic City, N. J., April 28.

B. T. Bectel, who has been in charge of the Pittsburgh office of the Mark Manufacturing Company, Evanston, Ill., since 1912, has been appointed assistant general manager of sales for this company, with headquarters at Evanston.

Walter Brunswick, formerly connected with the sales department of the American Locomotive Company, has been appointed engineer in charge of the engineering department of Dowler, Forbes & Co. of New York and Shanghai.

The Coleman Railway Supply Company has been organized by W. W. Coleman and George E. Neil as partners, with office at 30 Church street, New York. The company will handle a general line of railway appliances and supplies.

Richard A. Van Houten, for the past four years sales agent of the Sellers Manufacturing Company, Chicago, has been appointed manager of the plant at Mayfair (Chicago), where he will have complete charge of manufacturing operations.

E. L. Ruby, for the past year eastern representative for the Hayes Track Appliance Company, Richmond, Ind., has opened an office in the Real Estate Trust building, Philadelphia, Pa. In addition to Hayes derails he will handle the sale in eastern territory of the Keystone tool grinder made by the Keystone Grinder & Manufacturing Company, Pittsburgh, Pa.

G. A. Cooper, formerly in the copy service department of the Simmons-Boardman Publishing Company, Chicago, has been appointed a representative in the railroad department of the United States Graphite Company. His headquarters are at Chicago.

H. I. McMinn, formerly with the Pennsylvania Railroad, has entered the service of the Franklin Railway Supply Company as shop superintendent in charge of the manufacture of the Stone-Franklin lighting equipment, with headquarters at Bush Terminal, Brooklyn, New York.

F. H. Van Sweringen, formerly master car builder of the Streets Company and more recently superintendent of the Welland (Ont.) plant of the Canadian Steel Foundries, has been appointed Chicago representative of Brown & Co., Inc., Pittsburgh, Pa., makers of refined irons and steels.

The Acme Supply Company changed its corporate name on June 1 to the Dunbar Manufacturing Company. The sales organization will remain substantially the same, with the exception that a new sales office has been opened at St. Paul, Minn., with Rank & Goodell as sales representatives.

The Freeland derails and Newton replacers previously sold by the Hobart Alfree Company, Old Colony building, Chicago, have been sold to the Q & C Company, New York, St. Louis and Chicago, who will hereafter include these devices with the Fewings car replacers and the Q & C adjustable derails now sold by the Q & C Company.

J. B. Ennis, chief mechanical engineer of the American Locomotive Company, since December, 1912, has been appointed vice-president, in charge of engineering. Mr. Ennis has been in the service of the American Locomotive Company since its incorporation in 1901, prior to which time he was with the Rogers and Schenectady Locomotive Works.

John G. Barry has been appointed general sales manager of the General Electric Company. Mr. Barry has long been manager of the company's railway department, and is well known throughout the electrical industry. He began his business career as a production clerk for the Thomson-Houston Company at Lynn, Mass., in 1890. Soon, however, he was transferred to the company's Boston office in the commercial department. In 1892 the Thomson - Houston Company and the Edison General Electric Company were united to form the General Electric Company, and two years later Mr. Barry was transferred to Schenectady in the railway department. He was soon made assistant manager of the railway department, and in 1907 he was appointed manager of the department. Mr. Barry will continue his present duties as manager of the railway department.

J. G. Barry

At a special meeting of the board of directors of the Independent Pneumatic Tool Company, Chicago, held on May 3, to elect a successor to its late president, James Buchanan Brady, John D. Hurley, vice-president, was elected president. R. S. Cooper, manager of the New York office of this com-

pany, has been elected vice-president, succeeding Mr. Hurley. Robert T. Scott, manager of the company's Pittsburgh office, has been elected a director and member of the executive committee.

Keith R. Rodney, for many years connected with the Midvale Steel Company, and for the past two years supervisor of heat treating at the Winchester Repeating Arms Company, New Haven, Conn., has recently joined the staff of the Bullard Machine Tool Company as metallurgist and special counselor in the selection and treatment of steels.

J. W. Deetrick, for some years general manager of the Republic Iron & Steel Company, Youngstown, Ohio, has been elected second vice-president and also a director of the company. The title of general manager has been abolished, but Mr. Deetrick will continue to exercise supervision over operations at all of the plants and will be known as second vice-president in charge of operation.

In order to supply more readily the increasing demand for S K F bearings on the Pacific Coast, the S K F Ball Bearing Company, of California, Inc., has been organized. The main office of this company, under the direction of A. M. MacLaren, has been opened in San Francisco at 341 Larkin street. At this office a large and assorted stock of bearings will be carried, and the engineering services of the company will be available.

The Joliet Railway Supply Company, Chicago, has appointed Atkinson & Utech, Inc., 111 Broadway, New York, its eastern sales agents, to handle its business in eastern territory and all export business where the purchasing is done in New York. The Joliet Railway Supply Company has also appointed the following representatives: V. J. Burry, mechanical engineer, with headquarters in Chicago; Jos F. Leonard, Mutual building, Richmond, Va.; W. M. McClintock, Hackney building, St. Paul, Minn.; Alfred Connor, Majestic building, Denver, Col.; F. F. Bodler, Monadnock block, San Francisco, Cal.; W. F. McKenney, Portland, Ore.; S. I. Wailes, Los Angeles, Cal.

L. R. Pomeroy, consulting engineer, with office at 30 Church street, New York, died suddenly on May 7. Mr. Pomeroy had been in the railway and railway supply business for more than 35 years, and had a very wide acquaintance. He was born at Port Byron, N. Y., in 1857, and was educated at Irving Institute, Tarrytown, N. Y. From 1880 to 1886 he was secretary and treasurer of the Suburban Rapid Transit Company of New York, and then for nine years he was with the Carnegie Steel Company, introducing basic boiler steel for locomotives and special forgings. Subsequently he engaged in the same kind of work with the Cambria Steel Company and the Latrobe Steel Company jointly. For three years to 1902 he was assistant general manager of the Schenectady Locomotive Works, and then for six years represented in the railway field the General Electric Company. Then he went to the Safety Car Heating & Lighting Company, and afterwards to J. G. White & Co. as chief engineer of the railway and industrial divisions. In June, 1914, he was appointed manager of the New York sales office of the United States Light & Heating Company, and later opened an office as consulting engineer.

L. R. Pomeroy

Robert L. Gordon, assistant to the president of the Standard Steel Car Company, has been elected vice-president of that company, and vice-president of the Forged Steel Wheel Company and other associated companies, succeeding James B. Brady, deceased. Mr. Gordon graduated from Cornell University, class of 1895, with the degree of mechanical engineer, and after leaving college went with the Baldwin Locomotive Works. He was afterward connected with the Fox Pressed Steel Equipment Company, and later with the Pressed Steel Car Company, and has been connected with the Standard Steel Car Company since its organization, having acted as assistant to the president for the last 12 years.

Harry C. Quest, for a number of years a representative of paint and varnish companies in the railway supply field, has associated himself with A. A. Ridgway, in the Ridgeway-Quest Company, which was recently organized to manufacture paints and varnishes, at Chicago. Mr. Quest has been elected president of this company. He began his career in the railway supply business in 1901 with the Heath & Milligan Company, Chicago, and since then has been engaged in the sale of paints and varnishes to the railways, car companies and allied industries. The new plant of the Ridgway-Quest Company has been especially equipped for the production of these materials for the railway field. Mr. Quest will cover the entire United States. Branch offices will be established in New York City and Denver, Colo.

H. C. Quest

William Lodge, president of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, died suddenly April 31, 1917. William Lodge was born in Leeds, England, in 1848. He attended the common schools until at the age of 17 he became an apprentice at the machine shops of Fairburn & Co., of Leeds, where his term of indenture covered four years. He then came to the United States and resided in Philadelphia until 1872, when he went to Cincinnati, and shortly afterward became foreman in the shops of Steptoe, McFarland, Nottingham & Co. The senior member of the firm, John Steptoe, was the first machine-tool manufacturer west of the Alleghanies. After eight years with this concern, Mr. Lodge entered into partnership with William Barker, and they conducted a successful business in the manufacture of machine tools under the firm name of Lodge, Barker & Co. In 1886 Mr. Barker disposed of his interest to Charles Davis, and the company was reorganized under the name of Lodge & Davis. Six years later, in 1892, Mr. Lodge withdrew from the firm, and the same year organized the Ohio Machine Tool Company, the organization being continued till 1893, when he became associated with Murray Shipley, and the present company was incorporated under the name of the Lodge & Shipley Machine Tool Company, of which Mr. Lodge was president. Mr. Lodge was the author of "Rules of Management with Practical Instructions on Machine Building." He was a member of the American Society of Mechanical Engineers, joining the society in 1890.